



**Environmental Management Services Company**  
1413 West 57th Street  
Loveland, CO 80538  
(970) 461-0571 \* FAX (970) 461-0591

Transmit via fax

December 22, 1999

Mr. Don A. Ostler, P.E.  
Executive Secretary  
State of Utah  
Division of Water Quality  
288 North 1460 West  
Salt Lake City, UT 84114-4870

Re: Violation and Order, Docket No. UGW2003, North Lily Mining Company

Dear Mr. Ostler;

This letter is written to request an extension in the due date of Item 1, Notice of Violation and Order, Docket No. UGW2003 dated October 19, 1999, North Lily Mining Company. The original due date for this Item is Monday December 27, 1999. Because of the unavailability of key personnel due to the holiday season, an extension of approximately 14 days until Monday January 10, 2000 is respectfully requested. The extension will allow adequate internal review of the document prior to delivery of the Ground Water Contamination report to DWQ.

Thank you for your consideration of this request and please feel free to contact me if additional information can be provided.

Sincerely,

A handwritten signature in cursive script that reads 'Thomas E. Gast'. The signature is written in black ink and is positioned below the word 'Sincerely,'.

Thomas E. Gast  
Principal

CC: W. Gene Webb, North Lily Mining Company  
Ed Schneider, ESA Consultants, Inc.

0015

**Investigation of Potential  
Ground Water Contamination  
North Lily Mining Company's  
Silver City Heap Leach Facility  
Juab County, Utah**

**prepared by:  
Tom Gast  
Principal  
Environmental Management Services Company  
1413 West 57<sup>th</sup> Street  
Loveland, CO 80538  
970 / 461-0571  
and  
Ed Schneider, P.G.  
ESA Consultants Inc.  
2637 Midpoint Drive, Suite F  
Fort Collins, CO 80525  
970 / 484-3611**

**December 1999**

## 1. Introduction

North Lily Mining Company operated a cyanide gold leaching facility in Tintic Valley about one and one-quarter miles southwest of Mammoth, Juab County, Utah, on the west flank of the Tintic Mountains at Silver City, an abandoned mining town. Ore was obtained from former mine dumps throughout the area. Active leaching occurred during the period from 1988 through 1995. Since that time the facility has been maintained by company staff preparing for closure and reclamation.

Regarding Ground Water Quality Discharge Permits, North Lily Mining Company was issued a construction permit on April 13, 1988 for the facility. A second construction permit was issued on October 27, 1989 for a 600 x 300 foot extension of the original pad. Final Ground Water Quality Discharge Permit No. UGW230001 was issued May 20, 1991 for the existing facility and the proposed extensions to be built on the north and east sides of the existing facility. This permit was reissued in 1997.

Intending to close the facility in 1999, in the spring North Lily contracted a qualified firm to conduct feasibility studies regarding design of a biopass system. North Lily learned that the contractor was no longer in business when it called the contractor in August to discuss the feasibility report and to commission the design studies, which would have been forwarded to Division of Water Quality "DWQ" for review and approval. Because it was not possible to retain a replacement contractor, complete necessary studies, design the biopass system, gain DWQ's approval and construct the system in 1999, North Lily directed its efforts toward maintaining the facility with the intention of closing and reclaiming it in 2000.

Reacting to its concern regarding the facility, Division of Oil Gas and Mining "DOGM" and DWQ in October 1999 issued a Notice of Violation and Water Quality Order, respectively. Following a meeting with DOGM and DWQ staff on November 10, 1999, North Lily filed its response to the NOV on November 22, 1999 and Order items 2 through 7 on November 24, 1999. This report entitled "Investigation of Potential Ground Water Contamination at North Lily Mining Company's Silver City Heap Leach Facility Juab County, Utah" has been prepared to be responsive to Item 1 of the Order, which requires:

"Conduct a ground water contamination investigation and submit a report within 60 days of receipt of this ORDER assessing the impact or potential impact of the wastewater releases to groundwater including the extent and potential dispersion of the contamination. The report must document whether any remedial action will be necessary to maintain ground water quality. If the assessment shows remediation efforts are necessary, the report must include a Corrective Action Plan for undertaking these efforts."

The investigations have been conducted by and this report prepared by Tom Gast of Environmental Management Services Company and Ed Schneider of ESA Consultants Inc. Both Mr. Gast and Mr. Schneider have over 20 years experience in the

environmental field conducting site inspection investigations. A copy of their firm's experience and resumes of the principal investigators are included as a report appendix.

The Scope of Work appropriate for the investigation included: a comprehensive review of project documents including, but not limited to; project design documents; construction methods and testing documentation; permits, approvals and agency correspondence; monitoring reports; internal company documentation located both in Silver City and Denver; interviews of current and previous site personnel; and site inspection and water quality sampling. The result of our investigations are discussed below.

## **2. Background**

The Silver City heap leach facility was in active operation during the period from 1988 through 1995. From 1996 through the present North Lily has employed company personnel to maintain the site and prepare it for closure.

The heap leach site is located on a southwest sloping alluvial apron at an elevation of 6000 feet. According to Steffen, Robertson and Kirsten in their 1987 permit applications to DOGM and DWQ, precipitation is light, averaging about 14 inches per year.

## **3.0 Geology and Ground Water**

Geology is described as follows: "North Lily was required to drill a test well at the southwest end of the leach pad in January 1988, to a depth of 474 feet. The test hole site is downgradient of the pad. A neutron and gamma log was made of the hole, which was dry. The underlying alluvial deposits consist of sand, silt, gravel and clay to a depth of about 325 feet. Several beds of clay in the test hole are 25 to 30 feet thick. Bedrock was drilled from 325 to 474 feet. A test well about 500 feet deep was drilled several years previously about one quarter mile north of the pad. It also was dry." (DWQ, Final Ground Water Quality Discharge Permit No. UGW230001, May 20, 1991)

"Pits, 6 to 8 feet deep were dug with a backhoe at the pad site. The pits generally showed the underlying deposits consist of silty clay. When worked and compacted to decrease permeability these beds were used as layer 5 of the pad liner system. These clay beds were about 25 feet thick in the test hole, and offer a high degree of protection for ground water. Because of extensive clay beds at different depths, the Company was not required to drill an expensive deeper hole to the water table." (Final Ground Water Quality Discharge Permit No. UGW230001, May 20, 1991) Additional test pits, backhoe trenches and test borings were completed by SRK in the pad and pond area and these also showed the silty clay underlying the entire facility (SRK, 1987).

We have reviewed the test pit data developed by SRK (1987, 1988), Dames and Moore (1990), and the Well Completion Reports (Water, Waste and Land, 1991) and concur with DWQ's conclusion that clay lenses are present under the facility and that there is no ground water present to a depth of 474 feet.

Ground water in the mine area was determined by agreement of North Lily, its consultants and DWQ to be based upon a sample collected by North Lily from their production well NEL-1. This well is located in Tintic Valley about 1 mile west of the heap leach facility at a much lower elevation. The sample contained 365 mg/l TDS (total dissolved solids) and on the basis of the dissolved solids from the production well, the ground water was classified as Class 1A. Therefore it was agreed that the ground water requires a high degree of protection. Since the production well is downgradient the site, ground water beneath the pad is believed to be of similar quality at a depth of over 475 feet. The parties agreed that production well NEL-1 represented background water quality and that this well was to be monitored for potential contaminated discharges from the facility. (DWQ, Final Ground Water Quality Discharge Permit No. UGW230001, May 20, 1991)

#### 4.0 Facility Design and Construction

The leach pad, processing ponds and plant were designed as zero discharge facilities. During operations, all fluids were recirculated to the leach pad. Gold and silver ore on the leach pad was leached with a high pH solution containing NaCN. The high pH was maintained by the addition of NaOH although little of this reagent was required due to much of the ore being hosted in limestone. Cyanide solution containing gold and silver was collected at the base of the heap routed through pipes and ditches to the pregnant pond. The solution was pumped from the pregnant pond to the processing plant where gold and silver were removed by a Merrill-Crowe process, and the remaining solution was pumped and stored in the barren pond. Additional reagents, including cyanide were added to the solution stored in the barren pond and pumped to the sprinkler system atop the heap pad. Additional water was added to the barren pond to make up for the water lost by evaporation.

The facility design incorporated the pad liner system described below.

The leach pad vertical configuration starting at the top consists of several layers:

1. A three-foot thick protective layer of fine-grained ore.
2. A 30-mil PVC flexible membrane liner.
3. A twelve-inch minimum secondary clay liner installed at a standard density of 95 percent, having a hydraulic conductivity of  $1.0 \times 10^{-7}$  cm/sec. or less.
4. A geotextile having a hydraulic conductivity of  $1.0 \times 10^{-3}$  cm/sec over a 4-inch thick layer of leak detection media. At the bottom of the media, slotted sloping leak detection pipes were installed and dams placed along the axis locations to prevent clay infiltration into the slotted pipes.
5. A six-inch minimum engineered secondary clay liner compacted at 95 percent standard density having a hydraulic conductivity of  $1.0 \times 10^{-6}$  cm/sec or less.

The facility design incorporated the pond liner system described below.

The leach pond vertical configuration starting at the top consists of several layers:

1. A 40-mil HDPE flexible membrane liner.

2. A geotextile having a hydraulic conductivity of  $1.0 \times 10^{-3}$  cm/sec over a layer of leak detection media draining to a sump in each pond.
3. A 30-mil HDPE flexible membrane secondary liner.
4. An engineered and prepared foundation consisting of clay compacted at 95 percent standard density.

In the event of a break in the liner fluids will flow into sumps where they will be detected. The damaged components could then be repaired.

We have reviewed extensive correspondence between the project's design engineers (SRK and Dames & Moore) and DWQ regarding all aspects of the design. We conclude that the design was well reasoned and that there was ample review and agency oversight of the conceptual and detailed facility component designs. We have also reviewed the substantial construction management testing and quality assurance reports prepared by SRK and Dames & Moore, and confirmed by outside independent labs and reviewed by DWQ that demonstrate that the facility was constructed as designed.

### 5.0 Facility Operation

We have reviewed the quarterly monitoring reports and other correspondence between North Lily and DWQ regarding the facility's performance. There are several instances of fluids reporting to the sumps in quantities that required liner repairs. These were reported to DWQ and repairs were made in a timely fashion. DWQ, based upon the correspondence reviewed, was satisfied that the repairs were successfully completed and necessary quality assurance reports were filed during the repair process. There is no evidence that any fluid escaped the secondary containment systems for the pads and ponds described above.

There were several instances during the life of the facility that heap material slumped off the pad blocking the collection ditches. One of these instances was attributed to a thunderstorm event and another to a broken solution pipe that saturated an area of the heap resulting in the slope failure. According to Elwin Ewell (on site since 1989) and Paul Spor (facility manager from 1981 through 1997), these incidents were reported to DWQ and DOGM promptly and the spills cleaned up. Solution pipes and ditches were promptly repaired and ore was returned to the heap. It is estimated that approximately 25,000 gallons of solutions escaped during each of these incidents.

Given the quantity of solution lost and the speed of successful remedy, it is our opinion these incidents did not result in a serious impact to ground water given the depth to ground water and the presence of confining clay lenses beneath the area of release.

In November, sump monitoring was resumed. With one exception, the pad sumps were dry or were considered moist. One sump, sump #4 yielded between 35 and 45 gallons per week. Elwin Ewell stated that this sump was wet during operations but analysis never detected elevated pH or cyanide. Review of the sump monitoring reports filed with DWQ confirmed this fact. It is our recommendation that the sumps continue to be monitored

## Silver City Heap Leach

5

## Ground Water Investigation

Further, if the quantity of fluid evacuated from sump No. 4 remains between 35 and 45 gallons per week, the fluid should be analyzed for TDS and cyanide to determine if the fluid represents heap effluent or is attributable to natural sources.

North Lily is currently not able to monitor the sumps beneath the ponds. Assuming that there is effluent present in the sumps, the question is; has any fluid escaped the secondary liner? While we have not been able to inspect the secondary liners, we have carefully reviewed the pond construction reports. It is our opinion that the compacted clay beneath the secondary liners would successfully contain heap solutions in the event that the secondary pond liners were compromised. Copies of relevant solution pond compaction reports are included with this report. Permeability testing of project clay material placed and compacted as shown by the reports has been tested to have permeability ranging between  $3 \times 10^{-7}$  and  $1 \times 10^{-8}$  cm/sec or less.

### 6.0 Facility Inspection

The Silver City facility was inspected on November 9, 1999 by Tom Gast of EMS and Ed Schneider of ESA Consultants. Various project documents including permits, monitoring reports and agency facility inspection reports were reviewed prior to the inspection. Also present was Elwin Ewell of North Lily. The heap, solution ditches, ponds and buildings were systematically walked. Particular attention was directed to the condition of the facility, the liners and the functioning of the solution plumbing.

It was observed that the overflow primary liner was destroyed and that the overflow pond secondary liner had a large tear and several punctures. Also deteriorated was the spillway between the barren pond and the overflow pond. These conditions resulted in the overflow pond not being serviceable. During a post inspection meeting on November 11, 1999 with Steve Flechner and Gene Webb of North Lily, it was agreed that these areas required immediate repair. It is understood that repairs were completed by the end of November. Other areas requiring repair including the primary spillway and punctures in the primary liners in the pregnant and barren ponds were identified as requiring repair. North Lily reports that these repairs were completed during December 1999 and that the liners will be inspected and promptly repaired during the remaining life of the facility.

Several blocked areas within the solution ditches were identified. These areas apparently impounded solution such that during storm events the solution overtopped the ditch. Evidence of this is provided by the salt encrustation off the liner. While the areas encrusted were not large, this situation must be corrected. North Lily has agreed to dig out the areas of blockage and return the ditches to their required performance level. Given the small area of encrustation and the report that the overflow only occurred during storm events, it is not believed that the quantity of solution released was large and it is believed that the clay lenses below the facility has protected ground water from serious impact.

Other areas requiring attention were noted and corrective action plans implemented as described in the November correspondence to DWQ and DOGM.

## Silver City Heap Leach

6

## Ground Water Investigation

**7. Ground-Water Quality Assessment**

North Lily Mining Company retained the services of ESA Consultants Inc. and Chemtech-Ford Analytical Laboratories for collection and analysis of water samples from the North Lily heap leach facility. Samples were collected by ESA Consultants from two locations on November 9, 1999, as listed below:

1. Silver City supply well samples (duplicate samples) SCSW and SCPW
2. Heap Main Spillway sample SCMS

The field data sheets, chain of custody, and analysis results for these samples are enclosed. The heap leach sample was taken in compliance with Part I of the current permit, effective December 9, 1997.

The supply well samples were taken as part of the ground-water contamination investigation for assessing the existence of evidence of ground water degradation due to the heap leach facility. This well was sampled for this assessment because it was specified as the required point for ground-water compliance monitoring under the previous permit, No. 230001. Although ground-water monitoring requirements for this point of compliance were discontinued under the conditions of the existing permit, the June 20, 1997 Addendum to Statement of Basis for permit renewal states the following: "Rather than have North Lily install an expensive ground water monitoring system it was determined that monitoring of the Silver City supply well would provide a level of protection to the potentially impacted population." North Lily Mining Company, therefore, has re-sampled this supply well on the basis that it still provides "a level of protection to the potentially impacted population."

The review of existing ground-water quality monitoring data to date, including data compiled prior to commencement of Silver City heap leach operations, shows no evidence of degradation due to the heap leach facility. This assessment is based on a comparison of key indicator parameter concentration levels in heap leach solution with the concentration levels in the ground water. A key indicator parameter in this case is defined as having a concentration in the heap leach solution that is two or more orders of magnitude higher than the ground water background concentration, and therefore, has the most potential for causing a measurable increase in the background level.

The following tables show the key parameter values for both the heap leach solution and Silver City supply well over time. Data for the supply well show no evidence of ground water quality degradation to date.



## Silver City Heap Leach

7

## Ground Water Investigation

**CONCENTRATION BY SAMPLING DATE  
HEAP LEACH SOLUTION (mg/L)**

PARAMETER	11/99	09/99	10/97	12/96
Arsenic	0.89	0.9	0.26	0.31
Chloride	2,340	2,125	2,210	2,510
Copper	3.7	5.7	40.8	80.2
Cyanide (T)	1.07	20.9	43	62
Sodium	5,400	5,570	5,130	6,710
Sulfate	10,600	11,000	9,210	9,790
TDS	20,100	19,510	19,000	19,100

**CONCENTRATION BY SAMPLING DATE  
SILVER CITY SUPPLY WELL (mg/L)**

PARAMETER	11/99*	10/97	12/96	9/91	9/89	9/81
Arsenic	<0.005	<0.005	<0.005	<0.01	<0.01	0.004
Chloride	139	139	144	157	144	114
Copper	<0.01	0.01	0.003	<0.01	<0.015	<0.001
Cyanide (T)	<0.002	<0.002	<0.002	<0.002	<0.002	NA
Sodium	56	53.8	62.4	53	55	42
Sulfate	90	87	85	95	103	67.5
TDS	514	476	543	579	676	430

\*Values for 11/99 are the average of duplicate sample results for this date

The complete analysis report for each of the supply well sampling events listed above are enclosed.

### 8.0 Summary

A ground water contamination investigation of the North Lily heap leach facility has been conducted by Tom Gast of Environmental Management Services Company and Ed Schneider, P.G. of ESA Consultants Inc. North Lily and DWQ personnel fully cooperated with our investigation and openly provided documentation and freely gave their time. Based on our independent review of pertinent documents including site characterization reports, design documents, construction testing documents, monitoring reports, agency correspondence, our interview of those familiar with the facility and our site inspection, it is our opinion that the Silver City heap leach facility has not released significant quantities of wastewater resulting in harm to ground water. Based upon known information, we do not believe that ground water remediation efforts are necessary and consequently no Corrective Action Plan is included in this report.

### **NEL-1 Water Quality Analytical Results**

# CHEMTECH - FORD, INC.

COMPANY: ESA Consultants, Inc.  
 ADDRESS: 2637 Midpoint Dr, Suite F  
 CITY/STATE/ZIP: Fort Collins, CO 80525  
 PHONE #: 970 484-3611 FAX #: 970-484-4118  
 COMPANY CONTACT: Ed Schneider  
 PROJECT: Silver City Heap Facility 166.9901

Mark 'X' for copy to DEQ Div of Drinking Water

Lab - Linda Daniels - reporting  
 11/23 - Give Linda Field measurements  
 for samples to record on lab  
 analysis results - pH, temp. &  
 conductivity

ANALYSIS REQUEST FORM/CHAIN OF TODAY

BILLING NAME: North Lily Mining Company  
 BILLING ADDRESS: \_\_\_\_\_  
 P.O. #: \_\_\_\_\_  
 TURNAROUND REQUIRED: 2 wk  
 \*expedited turnaround subject to additional charge

Lab ID#	SAMPLE IDENTIFICATION	SAMPLE DATE	SAMPLE TIME	MATRIX					ANALYTES REQUESTED
				Water: Drink, Waste, Ground (circle)	Soil / Solid (circle)	Sediment, Solid, Liquid (circle)	Oil	Solvent	
1. SC SW		11/9/99	12:20	X					SEE ATTACHED LIST
2. SC PW		11/9/99	12:20	X					contains CN (includes Filtered sample) Field Filtered
3. SC MS		11/9/99	13:25	X					
4.									
5.									
6.									
7.									
8.									
9.									
10.									

Sampled by: (signature) Ed Schneider

Sampled by: (print) Ed Schneider

Special Instructions:

Sample Delivered by Courier:	
Relinquished by: (signature) <u>Ed Schneider</u>	Date/Time 11/9/99 17:20
Relinquished by: (signature)	Date/Time
Relinquished by: (signature)	Date/Time

CHEMTECH-FORD, INC. 5100 South Strader (380 West) Murray, UT 84107 Phone 801-262-7299 Fax 801-262-7378  
 NET 30 DAYS: 1.5% PER MONTH INTEREST CHARGE (18% A.P.R.) CUSTOMER AGREES TO PAY COLLECTION COSTS AND ATTORNEY'S FEES.

WHITE: ORIGINAL

YELLOW: CUSTOMER

PINK: FILE



# ESA Consultants Inc.

2637 Midpoint Drive, Suite F, Fort Collins, Colorado 80525

Telephone: (970) 484-3611 • FAX: (970) 484-4118

## PARAMETER LIST FOR SILVER CITY HEAP FACILITY MONITORING

### 3 Samples submitted for analysis

#### All samples MRL (mg/L)

TDS	10
Bicarbonate	1
Carbonate	1
Chloride	1
Sulfate	10

Calcium	0.1
Magnesium	0.1
Potassium	0.1
Sodium	0.1

Fluoride	0.1
Nitrite N	0.005
Nitrate + Nitrite N	

Metals (1 sample dissolved; 2 samples total)

Arsenic	0.005
Barium	0.005
Cadmium	0.001
Chromium	0.005
Copper	0.01

Lead	0.005
Mercury	0.0002
Selenium	0.002
Silver	0.005
Zinc	0.01

#### Plus Cyanide

1 sample:

WAD	0.5
Amenable to chlorination	0.5

2 samples: Total

0.002

SCSW  
SCPW

(1 sample will be field filtered for dissolved trace metals)

Sample ID

SCMS

SCSW & SCPW

Sampler: Ed Schneider E/D Date: 11/9/99 Time: 11:55  
Project: 166,9901 SILVER CITY HEAD REACH FACILITY

pH:	Model Number: <u>BEEKMAN pH/Temp</u>	Serial Number: <u>227699</u>
pH 7 buffer =	<u>7.05</u>	at <u>11.2</u> °C
	<u>CK. 7.04 @ 11.3°C</u>	
pH 10 buffer =	<u>10.17</u>	at <u>11.0</u> °C
pH 4 buffer =		at _____ °C

Electroconductivity:	Model Number: <u>YSI 30</u>	Serial Number: <u>95K42425</u>
Conductance Standard =	<u>Auto calibration</u>	μmhos/cm at 25°C
Measured Value =		μmhos/cm at _____ °C

Dissolved Oxygen:	Model Number: _____	Serial Number: _____
Measured Value =		mg/L at _____ °C

Turbidity:	Model Number: _____	Serial Number: _____
Measured Value =	_____ NTUs	Standard = _____ NTUs

INSTRUMENT  
CALIBRATION FORM



**ESA CONSULTANTS INC.**  
 2637 Midpoint Drive, Suite F  
 Fort Collins, Colorado 80525  
 (970) 484-3611 (970) 484-4118 FAX

### SURFACE WATER SAMPLING FORM

166.9901

Station ID: SCMSProject Name: SILVER CITY  
HEAP LEACH FACILITYLocation: Silver City Heap Main SpillwayDate: 11/9/99 Time: 13:10 - 13:25Weather Conditions: Clear, sunny, warmSampling Personnel (Signature): Richard J. Schneider

#### FIELD MEASUREMENTS

pH/Temp: 8.82 @ 13.6°C 8.82 @ 13.3°C Dissolved Oxygen/Temp (mg/L): —  
8.83 @ 13.3°C → 22,250, 22,230, 22,230  
 Specific Conductance/Temp ( $\mu\text{S}/\text{cm}$ ): 22.25, 22.23, 22.23  
ms/cm

Fe (II) (mg/L): — Fe (total)(mg/L): —Alkalinity (mg/L as  $\text{CaCO}_3$ ): — Calculated Streamflow (cfs): —COMMENTS: Field Filtered sample for dissolved trace metals;  
sample clean w/ light yellow-brown color

#### WATER QUALITY SAMPLES

Sample ID

Containers

Tag No.	Date/Time	Preserved	Analysis
		<u>@ 4°C - on ice</u>	
<u>SCMS</u>	<u>11/9/13:25</u>	<u>none</u>	<u>Major, TDS</u>
<u>↓</u>	<u>↓</u>	<u>HNO<sub>3</sub></u>	<u>Total &amp; Dissolved metals (2 containers)</u>
<u>↓</u>	<u>↓</u>	<u>H<sub>2</sub>SO<sub>4</sub></u>	<u>Nutrients - NO<sub>3</sub> - NO<sub>2</sub> - N</u>
<u>↓</u>	<u>↓</u>	<u>NaOH</u>	<u>WAD &amp; Alkalinity amenable CN</u>
<u> </u>	<u> </u>	<u> </u>	<u> </u>
<u> </u>	<u> </u>	<u> </u>	<u> </u>
<u> </u>	<u> </u>	<u> </u>	<u> </u>
<u> </u>	<u> </u>	<u> </u>	<u> </u>

Site Sketch:

Log Book #       
Page 1 of 1

166.9901 SILVER CITY HEAP LEACH FACILITY

Well ID No. <u>SCSW</u> <u>Silver City</u> <u>Supply Well</u>	Unit Storage Volume (gal./ft.) = 5.8752 (D <sup>3</sup> ) Where D = well diameter (ft.)	Samplers Initials: <u>EJS</u>	Date: <u>11/9/99</u>	Time:
Casing Diameter <u>8</u> in.	1" I.D. = 0.0408 gal./ft. 2" I.D. = 0.1632 gal./ft. 3" I.D. = 0.3672 gal./ft. 4" I.D. = 0.6528 gal./ft. 5" I.D. = 1.0200 gal./ft. 6" I.D. = 1.4688 gal./ft. 8" = 2.6112 gal./ft.	Purge Equipment: <input type="checkbox"/> Bailer <input checked="" type="checkbox"/> Pump	Sampling Equipment: <input type="checkbox"/> Bailer <input checked="" type="checkbox"/> Pump	
Total Depth <u>545</u> ft.		Type/Material:	Type/Material:	
Static Water Level <u>Well Head</u> <u>Inaccessible</u> ft.	<u>Pre-pumped about 26 hrs.</u> <u>prior to sampling</u>			
Saturated Thickness <u>Estimate</u> <u>230'</u> ft.				

Casing Volume 600 gal.

Casing Volume 1,800 x3 (gal)

Well Location: NW 1/4, NE 1/4, NW 1/4, Sec. 35, T10S, R3W, Juab CO.,  
UTAH; approximately 1,500' east and 400' south  
of NW corner of Sec. 35; approximately 2,100'  
SW of Hwy 6 and Hwy 36 junction.

Sampling Point: @ water supply tank inlet (PVC pipe)

Time	No. of Casing Volumes	Gallons Removed	Temp (°C)	Conductivity (µmhos/cm)	pH	Eh	Diss. O <sub>2</sub> (mg/L)	Pump Rate (gpm)	Approx. Pump Depth (ft.)	Visual Description
<u>Start</u>	<u>#</u>	<u>@ 10'</u>	<u>30</u>	<u>11/8/99 to Flush - continuous</u>	<u>@ 25 gpm ±</u>					
<u>12:05</u>			<u>15.5</u>	<u>644 @ 25°C</u>	<u>7.12</u>			<u>25 ±</u>		<u>clear, clean</u>
<u>12:07</u>			<u>15.9</u>	<u>652 @ 25°C</u>	<u>7.29</u>					
<u>12:10</u>			<u>15.8</u>	<u>654 @ 25°C</u>	<u>7.35</u>					
<u>12:12</u>			<u>15.7</u>	<u>653 @ 25°C</u>	<u>7.41</u>					
<u>12:15</u>			<u>15.6</u>	<u>653 @ 25°C</u>	<u>7.56</u>					

12:18  
Analysis Requested: 15.7 652 @ 25°C 7.56

- ☐ Organics (DOC, DOX, BTEX, VOC, SVOC)
- ☒ Dissolved Metals (Specify) + majors
- ☒ Nitrate/Nitrite
- ☒ Other (Specify) Total CN  
See Parameter List w/ chain of  
custody form

Condition of Well/Remarks:

\* pumped 1550 minutes x 25 gpm =  
38,750 gal prior to  
sampling

Duplicate Sample ID = SC.PWSampler Signature: Ethel J. Schuster

**ESA CONSULTANTS INC.**  
2637 Midpoint Drive, Suite F  
Fort Collins, Colorado 80525  
(970) 484-3611 (970) 484-4118 FAX

**GROUNDWATER  
SAMPLING FORM**

## CHEMTECH-FORD



Date: 11/29/99

To: ESA Consultants, Inc.  
attn. Ed Schneider  
2637 Midpoint Drive, Ste. F  
Fort Collins, CO 80525

Group #: 33796  
Lab #: 99-U010989  
Project: SILVER CITY HEAP FAC.166.9901  
Sample Desc: SCSW *Supply well*  
Sample Matrix: WATER  
Date Sampled: 11/ 9/99  
Date Submitted: 11/ 9/99

Time Sampled: 12:20  
Time Received: 17:20

## CERTIFICATE OF ANALYSIS

PARAMETER	RESULT	MINIMUM REPORTING		DATE ANALYZED	METHOD	ANALYST
		LIMIT (MRL)				
INORGANIC PARAMETERS						
Alkalinity,as Bicarbonate, mg/L	133	1		11/11/99 10:00	SM 2320B	PNM
Alkalinity, as Carbonate, mg/L	< 1	1		11/11/99 10:00	SM 2320B	PNM
Chloride (D), mg/L	136	1		11/11/99 14:00	EPA 325.3	PNM
Conductance, Field, umhos/cm 25degC	652	1		11/ 9/99 12:18	EPA 120.1	Client
Cyanide, Total, mg/L	< 0.002	0.002		11/19/99 14:40	ASTM D2036	EJB
Fluoride, mg/L	0.2	0.1		11/15/99 10:30	EPA 340.2	TSM
Mercury, as Hg Total, mg/L	< 0.0002	0.0002		11/19/99 10:29	EPA 245.2	MJB
Nitrite, Nitrogen, mg/L	< 0.005	0.005		11/10/99 17:15	EPA 354.1	LC
Nitrate+Nitrite-Total, mg/L	1.2	0.1		11/18/99 12:00	EPA 353.1	EJB
pH, Field, Units	7.56	0.05		11/ 9/99 12:18	EPA 150.1	Client
Sulfate, mg/L	89	25		11/12/99 13:18	EPA 375.4	PNM
Total Dissolved Solids, mg/L	532	10		11/18/99 12:00	EPA 160.1	LPS
Barium (T), as Ba, mg/L	0.069	0.005		11/11/99 11:55	EPA 200.7	EG
Calcium (T), as Ca, mg/L	52	0.2		11/11/99 11:55	EPA 200.7	EG
Chromium(T), as Cr, mg/L	< 0.005	0.005		11/11/99 11:55	EPA 200.7	EG

Approved By: 

Ron Fuller, Laboratory Director

MRL = Report detection limit

Page 1

(generic.rpt)

6100 SOUTH STRATLER  
SALT LAKE CITY UTAH 84107 6905  
801 262 7299 PHONE  
801 262 7378 FAX



## CHEMTECH-FORD



Date: 11/29/99

To: ESA Consultants, Inc.  
attn. Ed Schneider  
2637 Midpoint Drive, Ste. F  
Fort Collins, CO 80525

Group #: 33796  
Lab #: 99-U010989  
Project: SILVER CITY HEAP FAC.166.9901  
Sample Desc: SCSW *Supply well*  
Sample Matrix: WATER  
Date Sampled: 11/ 9/99  
Date Submitted: 11/ 9/99

Time Sampled: 12:20  
Time Received: 17:20

## CERTIFICATE OF ANALYSIS

PARAMETER	RESULT	MINIMUM REPORTING		DATE ANALYZED	METHOD	ANALYST
		LIMIT (MRL)				
INORGANIC PARAMETERS						
Copper (T), as Cu, mg/L	< 0.01	0.01	11/11/99	11:55	EPA 200.7	EG
Magnesium (T), as Mg, mg/L	28	0.2	11/11/99	11:55	EPA 200.7	EG
Potassium (T), as K, mg/L	2.9	0.2	11/11/99	11:55	EPA 200.7	EG
Sodium (T), as Na, mg/L	56	0.2	11/11/99	11:55	EPA 200.7	EG
Zinc (T), as Zn, mg/L	0.02	0.01	11/11/99	11:55	EPA 200.7	EG
Arsenic (T), as As, mg/L	< 0.005	0.005	11/19/99	9:50	EPA 200.9	EG
Cadmium (T), as Cd, mg/L	< 0.001	0.001	11/19/99	11:29	EPA 200.9	EG
Lead (T), as Pb, mg/L	< 0.005	0.005	11/23/99	9:12	EPA 200.9	EG
Selenium (T), as Se, mg/L	< 0.002	0.002	11/19/99	13:59	EPA 200.9	EG
Silver (T), as Ag, mg/L	0.0006	0.0005	11/11/99	12:57	EPA 200.9	EG
Temperature, Field, deg. C	15.7	0.1	11/ 9/99	12:18	EPA 170.1	Client
Temperature, Receiving, C	3.3		11/ 9/99	17:20		CSM

Approved By: 

Ron Fuller, Laboratory Director

MRL = Report detection limit

Page 2

(generic.rpt)

6100 SOUTH STRATLER  
SALT LAKE CITY UTAH 84107 6905  
801 262 7299 PHONE  
801 262 7378 FAX

## CHEMTECH-FORD



Date: 11/29/99

To: ESA Consultants, Inc.  
attn. Ed Schneider  
2637 Midpoint Drive, Ste. F  
Fort Collins, CO 80525

Group #: 33796  
Lab #: 99-U010989  
Project: SILVER CITY HEAP FAC.166.9901  
Sample Desc: SCSW *Supply Well*  
Sample Matrix: WATER  
Date Sampled: 11/ 9/99  
Date Submitted: 11/ 9/99

Time Sampled: 12:20  
Time Received: 17:20

## CERTIFICATE OF ANALYSIS

PARAMETER	RESULT	MINIMUM REPORTING		METHOD	ANALYST
		LIMIT (MRL)	DATE ANALYZED		
INORGANIC PARAMETERS					

NOTE: Sample received on ice.  
The analyst Client refers to field data provided  
by ESA Consultants, Inc.

Approved By: 

Ron Fuller, Laboratory Director

MRL = Report detection limit

Page 3

{generic.rpt}

6100 SOUTH STRATLER  
SALT LAKE CITY UTAH 84107 6905  
801 262 7299 PHONE  
801 262 7378 FAX

## CHEMTECH-FORD



Date: 11/29/99

To: ESA Consultants, Inc.  
attn. Ed Schneider  
2637 Midpoint Drive, Ste. F  
Fort Collins, CO 80525

Group #: 33796  
Lab #: 99-U010990  
Project: SILVER CITY HEAP FAC.166.9901  
Sample Desc: SCPW *Supply Well Duplicate*  
Sample Matrix: WATER  
Date Sampled: 11/ 9/99  
Date Submitted: 11/ 9/99

Time Sampled: 12:30  
Time Received: 17:20

## CERTIFICATE OF ANALYSIS

PARAMETER	RESULT	MINIMUM REPORTING		DATE ANALYZED	METHOD	ANALYST
		LIMIT	DATE			
		(MRL)				
INORGANIC PARAMETERS						
Alkalinity,as Bicarbonate, mg/L	137	1	11/11/99	10:00	SM 2320B	PNM
Alkalinity, as Carbonate, mg/L	< 1	1	11/11/99	10:00	SM 2320B	PNM
Chloride (D), mg/L	141	5	11/11/99	14:00	EPA 325.3	PNM
Conductance, Field, umhos/cm 25degC	652	1	11/ 9/99	12:18	EPA 120.1	Client
Cyanide, Total, mg/L	< 0.002	0.002	11/19/99	14:40	ASTM D2036	EJB
Fluoride, mg/L	0.2	0.1	11/15/99	10:30	EPA 340.2	TSM
Mercury, as Hg Total, mg/L	< 0.0002	0.0002	11/19/99	10:29	EPA 245.2	MJB
Nitrite, Nitrogen, mg/L	< 0.005	0.005	11/10/99	17:15	EPA 354.1	LC
Nitrate+Nitrite-Total, mg/L	1.2	0.1	11/18/99	12:00	EPA 353.1	EJB
pH, Field, Units	7.56	0.05	11/ 9/99	12:18	EPA 150.1	Client
Sulfate, mg/L	91	25	11/12/99	13:18	EPA 375.4	PNM
Total Dissolved Solids, mg/L	496	10	11/18/99	12:00	EPA 160.1	LPS
Barium (T), as Ba, mg/L	0.071	0.005	11/11/99	11:55	EPA 200.7	EG
Calcium (T), as Ca, mg/L	52	0.2	11/11/99	11:55	EPA 200.7	EG
Chromium(T), as Cr, mg/L	< 0.005	0.005	11/11/99	11:55	EPA 200.7	EG

Approved By: 

Ron Fuller, Laboratory Director

MRL = Report detection limit

Page 4

{generic.rpt}

6100 SOUTH STRATLER  
SALT LAKE CITY UTAH 84107 6905  
801 262 7299 PHONE  
801 262 7378 FAX

## CHEMTECH-FORD



Date: 11/29/99

To: ESA Consultants, Inc.  
attn. Ed Schneider  
2637 Midpoint Drive, Ste. F  
Fort Collins, CO 80525

Group #: 33796

Lab #: 99-U010990

Project: SILVER CITY HEAP FAC.166.9901

Sample Desc: SCPW *Supply Well Duplicate*

Sample Matrix: WATER

Date Sampled: 11/ 9/99

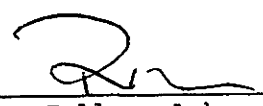
Date Submitted: 11/ 9/99

Time Sampled: 12:30

Time Received: 17:20

## CERTIFICATE OF ANALYSIS

PARAMETER	RESULT	MINIMUM REPORTING		DATE ANALYZED	METHOD	ANALYST
		LIMIT (MRL)				
INORGANIC PARAMETERS						
Copper (T), as Cu, mg/L	< 0.01	0.01	11/11/99	11:55	EPA 200.7	EG
Magnesium (T), as Mg, mg/L	29	0.2	11/11/99	11:55	EPA 200.7	EG
Potassium (T), as K, mg/L	3.0	0.2	11/11/99	11:55	EPA 200.7	EG
Sodium (T), as Na, mg/L	56	0.2	11/11/99	11:55	EPA 200.7	EG
Zinc (T), as Zn, mg/L	0.02	0.01	11/11/99	11:55	EPA 200.7	EG
Arsenic (T), as As, mg/L	< 0.005	0.005	11/19/99	9:50	EPA 200.9	EG
Cadmium (T), as Cd, mg/L	< 0.001	0.001	11/19/99	11:29	EPA 200.9	EG
Lead (T), as Pb, mg/L	< 0.005	0.005	11/23/99	9:12	EPA 200.9	EG
Selenium (T), as Se, mg/L	< 0.002	0.002	11/19/99	13:59	EPA 200.9	EG
Silver (T), as Ag, mg/L	< 0.0005	0.0005	11/11/99	12:57	EPA 200.9	EG
Temperature, Field, Deg. C	15.7	0.1	11/ 9/99	12:18	EPA 170.1	Client
Temperature, Receiving, C	3.0		11/ 9/99	17:20		CSM

Approved By: 

Ron Fuller, Laboratory Director

MRL = Report detection limit

Page 5

{generic.rpt}

6100 SOUTH STRATLER  
SALT LAKE CITY UTAH 84107 6905  
801 262 7299 PHONE  
801 262 7378 FAX

## CHEMTECH-FORD



Date: 11/29/99

To: ESA Consultants, Inc.  
attn. Ed Schneider  
2637 Midpoint Drive, Ste. F  
Fort Collins, CO 80525

Group #: 33796  
Lab #: 99-U010990  
Project: SILVER CITY HEAP FAC.166.9901  
Sample Desc: SCPW *Supply Well Duplicate*  
Sample Matrix: WATER  
Date Sampled: 11/ 9/99  
Date Submitted: 11/ 9/99

Time Sampled: 12:30  
Time Received: 17:20

## CERTIFICATE OF ANALYSIS

PARAMETER	RESULT	MINIMUM REPORTING		METHOD	ANALYST
		LIMIT (MRL)	DATE ANALYZED		
INORGANIC PARAMETERS					

NOTE: Sample received on ice.  
The analyst Client refers to field data provided  
by ESA Consultants, Inc.

Approved By: 

Ron Fuller, Laboratory Director

MRL = Report detection limit

Page 6

(generic.rpt)

6100 SOUTH STRATLER  
SALT LAKE CITY UTAH 84107 6905  
801 262 7299 PHONE  
801 262 7378 FAX

CHEMTECH-FORD

ANALYTICAL LABORATORIES



Date: 10/21/97

To: North Lily Mining Company  
 attn: Paul Spor  
 390 South 600 East  
 St. George, UT 84770

Group #: 18647  
 Lab #: 97-U011032  
 Project: SILVER CITY  
 Sample Desc: Well Water Tap

Date Sampled: 10/ 1/97  
 Date Submitted: 10/ 1/97

Time Sampled: 12:15  
 Time Received: 13:55

## CERTIFICATE OF ANALYSIS

PARAMETER	RESULT	MDL	DATE ANALYZED	METHOD	ANALYST
INORGANIC PARAMETERS					
Bicarbonate as HCO <sub>3</sub> , mg/L	129	1	10/ 7/97 10:30	SM 2320B	TM
Carbonate as CO <sub>3</sub> , mg/L	< 1	1	10/ 7/97 10:30	SM 2320B	TM
Alkalinity, Solids, mg/L	64	1	10/ 7/97 10:30	SM 2320B	TM
Hydroxide as OH, mg/L	< 1	1	10/ 7/97 10:30	SM 2320B	TM
Alkalinity, Total (CaCO <sub>3</sub> ), mg/L	106	1	10/ 7/97 10:30	SM 2320B	TM
Carbon Dioxide, mg/L	95	1	10/ 7/97 10:30	SM 4500 D	TM
Chloride (D), mg/L	139	1	10/ 3/97 17:00	EPA 325.3	TM
Conductance, Specific, umhos/cm	949.8	0.1	10/ 6/97 14:00	EPA 120.1	KRF
Cyanide (T), mg/L	< 0.002	0.002	10/10/97 15:00	ASTM D2036	TPH
Fluoride, mg/L	0.2	0.1	10/15/97 8:00	EPA 340.2	EG
Hardness, EDTA Titration, mg/L	256	17	10/11/97 11:00	EPA 130.2	TM
Hardness Index: Hard Water					
Mercury (T), as Hg, mg/L	< 0.0002	0.0002	10/ 8/97 9:35	EPA 245.1	EG
Nitrite, Nitrogen, mg/L	< 0.005	0.005	10/ 3/97 6:30	EPA 354.1	TM
Nitrate/Nitrite-Nitrogen, mg/L	0.86	0.08	10/ 6/97 11:07	EPA 353.1	LH
pH, units	7.60	0.05	10/ 1/97 15:45	EPA 150.1	LS
Phosphorus, Ortho, mg/L	< 0.01	0.01	10/ 3/97 10:30	SM 4500E	AJP
Sulfate, mg/L	87	33	10/ 6/97 10:30	EPA 375.4	TM
Total Dissolved Solids, mg/L	476	10	10/ 6/97 14:45	EPA 160.1	LS
Total Suspended Solids, mg/L	3	1	9/30/97 15:45	EPA 160.2	LS

Approved By: H. H.

(generic.rpt)

6100 SOUTH STRATLER  
 SALT LAKE CITY UTAH 84107 6905  
 801 262 7299 PHONE  
 801 262 7378 FAX

CHEMTECH-FORD

ANALYTICAL LABORATORIES



Date: 10/21/97

To: North Lily Mining Company  
attn: Paul Spor  
390 South 600 East  
St. George, UT 84770

Group #: 18647  
Lab #: 97-U011032  
Project: SILVER CITY  
Sample Desc: Well Water Tap

Date Sampled: 10/ 1/97  
Date Submitted: 10/ 1/97

Time Sampled: 12:15  
Time Received: 13:55

## CERTIFICATE OF ANALYSIS

PARAMETER	RESULT	MDL	DATE ANALYZED	METHOD	ANALYST
INORGANIC PARAMETERS					
Turbidity, NTU	2.93	0.05	10/ 1/97 15:40	EPA 180.1	LS
Barium (T), as Ba, mg/L	0.054	0.005	10/ 2/97 10:59	EPA 200.7	LH
Beryllium (T), as Be, mg/L	< 0.001	0.001	10/ 2/97 10:59	EPA 200.7	LH
Calcium (T), as Ca, mg/L	51.7	0.1	10/ 2/97 10:59	EPA 200.7	LH
Chromium(T), as Cr, mg/L	< 0.005	0.005	10/ 2/97 10:59	EPA 200.7	LH
Copper (T), as Cu, mg/L	0.01	0.01	10/ 2/97 10:59	EPA 200.7	LH
Iron (T), as Fe, mg/L	0.30	0.02	10/ 2/97 10:59	EPA 200.7	LH
Magnesium (T), as Mg, mg/L	30.3	0.1	10/ 2/97 10:59	EPA 200.7	LH
Manganese (T), as Mn, mg/L	0.02	0.01	10/ 2/97 10:59	EPA 200.7	LH
Nickel (T), as Ni, mg/L	< 0.01	0.01	10/ 2/97 10:59	EPA 200.7	LH
Potassium (T), as K, mg/L	3.2	0.1	10/ 2/97 10:59	EPA 200.7	LH
Sodium (T), as Na, mg/L	53.8	0.1	10/ 2/97 10:59	EPA 200.7	LH
Zinc (T), as Zn, mg/L	0.04	0.01	10/ 2/97 10:59	EPA 200.7	LH
Antimony (T), as Sb, mg/L	< 0.002	0.002	10/ 9/97 13:33	EPA 200.9	EG
Arsenic (T), as As, mg/L	< 0.005	0.005	10/ 8/97 9:06	EPA 200.9	EG
Cadmium (T), as Cd, mg/L	< 0.001	0.001	10/ 6/97 8:46	EPA 200.9	EG
Lead (T), as Pb, mg/L	< 0.005	0.005	10/ 7/97 14:01	EPA 200.9	EG
Selenium (T), as Se, mg/L	0.005	0.002	10/ 7/97 10:13	EPA 200.9	EG
Silver (T), as Ag, ug/L	< 0.5	0.5	10/10/97 10:04	EPA 200.9	EG
Thallium (T), as Tl, mg/L	< 0.001	0.001	10/ 9/97 9:49	EPA 200.9	EG

Approved By: H. H. H.

{generic.rpt}

6100 SOUTH STRATLER  
SALT LAKE CITY UTAH 84107 6905  
801 262 7299 PHONE  
801 262 7378 FAX

**CHEMTECH-FORD**

## ANALYTICAL LABORATORIES



Date: 10/21/97

To: North Lilly Mining Company  
attn: Paul Spor  
390 South 600 East  
St. George, UT 84770

Group #: 18647  
Lab #: 97-U011032  
Project: SILVER CITY  
Sample Desc: Well Water Tap

Date Sampled: 10/ 1/97  
Date Submitted: 10/ 1/97

Time Sampled: 12:15  
Time Received: 13:55

## CERTIFICATE OF ANALYSIS

PARAMETER	RESULT	MDL	DATE ANALYZED	METHOD	ANALYST
INORGANIC PARAMETERS					
Cation, meq/L	7.51				
Anion, meq/L	7.87				
% Difference,	2.33				
Receiving Temperature, C	26.7		10/ 1/97 13:55		RCG

NOTE: Sample submitted not on ice.

Approved By:

{generic.rpt}

6100 SOUTH STRATLER  
SALT LAKE CITY UTAH 84107 6905  
801 262 7299 PHONE  
801 262 7378 FAX



## CHEMTECH-FORD

## ANALYTICAL LABORATORIES



Date: 12/31/96

To: North Lily Mining Company  
attn. Paul Spor  
P.O. Box 421  
Eureka, UT 84628

Group #: 12068  
Lab #: 96-U017465  
Project: SILVER CITY  
Sample Desc: Well Storage Inlet

Date Sampled: 12/ 9/96  
Date Submitted: 12/ 9/96

Time Sampled: 8:30  
Time Received: 10:45

## CERTIFICATE OF ANALYSIS

PARAMETER	RESULT	MDL	DATE ANALYZED		METHOD	ANALYST
INORGANIC PARAMETERS						
Beryllium (T), as Be, mg/L	< 0.0002	0.0002	12/17/96	9:31	EPA 200.7	LH
Cadmium (T), as Cd, mg/L	< 0.001	0.001	12/17/96	9:31	EPA 200.7	LH
Calcium (T), as Ca, mg/L	60.1	0.02	12/24/96	10:06	EPA 200.7	LH
Chromium (T), as Cr, mg/L	0.002	0.001	12/17/96	9:31	EPA 200.7	LH
Copper (T), as Cu, mg/L	0.003	0.002	12/17/96	9:31	EPA 200.7	LH
Iron (T), as Fe, mg/L	0.044	0.005	12/24/96	10:06	EPA 200.7	LH
Lead (T), as Pb, mg/L	< 0.01	0.01	12/17/96	9:31	EPA 200.7	LH
Magnesium (T), as Mg, mg/L	33.2	0.02	12/24/96	10:06	EPA 200.7	LH
Manganese (T), as Mn, mg/L	0.004	0.002	12/17/96	9:31	EPA 200.7	LH
Nickel (T), as Ni, mg/L	< 0.002	0.002	12/17/96	9:31	EPA 200.7	LH
Potassium (T), as K, mg/L	3.4	0.5	12/24/96	10:06	EPA 200.7	LH
Silver (T), as Ag, mg/L	< 0.001	0.001	12/17/96	9:31	EPA 200.7	LH
Sodium (T), as Na, mg/L	62.4	0.02	12/24/96	10:06	EPA 200.7	LH
Zinc (T), as Zn, mg/L	0.032	0.002	12/17/96	9:31	EPA 200.7	LH
Antimony (T), as Sb, mg/L	< 0.003	0.003	12/17/96	9:52	EPA 200.9	EG
Arsenic (T), as As, mg/L	< 0.005	0.005	12/13/96	9:17	EPA 200.9	EG
Selenium (T), as Se, mg/L	< 0.002	0.002	12/19/96	11:06	EPA 200.9	EG
Thallium (T), as Tl, mg/L	< 0.001	0.001	12/18/96	14:17	EPA 200.9	EG
Cation, meq/L	8.54					
Anion, meq/L	8.15					
% Difference,	-2.31					

Approved By: 

1250 LAMOILLE HWY (generic.rpt)  
ELKO, NEVADA 89801  
702 738 0111 PHONE  
702 753 7255 FAX

6100 SOUTH STRATLER  
SALT LAKE CITY UTAH 84107 6905  
801 262 7299 PHONE  
801 262 7378 FAX

CHEMTECH-FORD

ANALYTICAL LABORATORIES



Date: 12/31/96

To: North Lily Mining Company  
attn. Paul Spor  
P.O. Box 421  
Eureka, UT 84628

Group #: 12068  
Lab #: 96-U017465  
Project: SILVER CITY  
Sample Desc: Well Storage Inlet

Date Sampled: 12/ 9/96  
Date Submitted: 12/ 9/96

Time Sampled: 8:30  
Time Received: 10:45

## CERTIFICATE OF ANALYSIS

PARAMETER	RESULT	MDL	DATE ANALYZED	METHOD	ANALYST
INORGANIC PARAMETERS					
Bicarbonate as HCO <sub>3</sub> , mg/L	140	1	12/10/96 13:00	SM 2320B	TM
Carbonate as CO <sub>3</sub> , mg/L	< 1	1	12/10/96 13:00	SM 2320B	TM
Alkalinity, Solids, mg/L	69	1	12/10/96 13:00	SM 2320B	TM
Hydroxide as OH, mg/L	< 1	1	12/10/96 13:00	SM 2320B	TM
Alkalinity, Total, mg/L	115	1	12/10/96 13:00	SM 2320B	TM
Carbon Dioxide, mg/L	104	1	12/10/96 13:00	SM 4500 D	TM
Chloride (D), mg/L	144	3.3	12/11/96 9:00	EPA 325.3	TM
Conductance, Specific, umhos/cm	843	0.1	12/11/96 9:50	EPA 120.1	KRF
Cyanide (T), mg/L	< 0.002	0.002	12/19/96 9:15	ASTM D2036	TH
Fluoride, mg/L	0.2	0.1	12/11/96 14:00	EPA 340.2	EG
Hardness, EDTA Titration, mg/L	272	25	12/16/96 12:00	EPA 130.2	TM
Mercury (T), as Hg, mg/L	< 0.0002	0.0002	12/20/96 14:00	EPA 245.1	BJP
Nitrite, Nitrogen, mg/L	< 0.005	0.005	12/ 9/96 17:30	EPA 354.1	BJP
Nitrate/Nitrite-Nitrogen, mg/L	0.77	0.08	12/10/96 10:27	EPA 353.1	TH
pH, units	7.50	0.05	12/10/96 14:00	EPA 150.1	LS
Phosphorus, Ortho, mg/L	0.01	0.01	12/ 9/96 18:00	4500-P-E	BJP
Sulfate, mg/L	85	33	12/10/96 9:00	EPA 375.4	TM
Total Dissolved Solids, mg/L	543	12	12/ 9/96 3:00	EPA 160.1	JBR
Total Suspended Solids, mg/L	< 2.5	2.5	12/11/96 12:55	EPA 160.2	LS
Turbidity, NTU	0.58	0.05	12/11/96 12:50	EPA 180.1	LS
Barium (T), as Ba, mg/L	0.062	0.002	12/17/96 9:31	EPA 200.7	LH

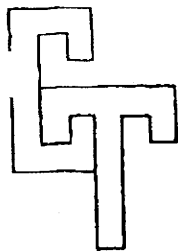
Approved By: 

1250 LAMOILLE HWY (generic.rpt)  
ELKO, NEVADA 89801  
702 738 0111 PHONE  
702 753 7255 FAX

6100 SOUTH STRATLER  
SALT LAKE CITY UTAH 84107 6905  
801 262 7299 PHONE  
801 262 7378 FAX

0-18-91 FRI 15:02

P.02



# CHEMTECH

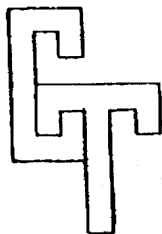
ANALYTICAL LABORATORY

6100 S. STRATLER  
MURRAY, UTAH 84107  
PHONE: (801) 262-7299  
FAX: (801) 262-7378

## CERTIFICATE OF ANALYSIS

SAMPLE IDENTIFICATION		PARAMETER	DETECTED
CLIENT: North Lilly Mining Co.	:	Conductivity, umhos/cm.....	663
P.O. Box 421	:	Copper as Cu, mg/l.....	<.01
Eureka, Utah 84068	:	Fluoride as F, mg/l.....	0.36
LAB NO: 69314	:	Hardness as CaCO <sub>3</sub> , mg/l.....	308
DATE SAMPLED: 10-07-91	:	Hydroxide as OH, mg/l.....	0
TIME SAMPLED: 0900	:	Iron as Fe (Diss), mg/l.....	0.10
SAMPLED BY:	:	Iron as Fe (Tot), mg/l.....	0.21
LOCATION: Well Storage Tank	:	Lead as Pb, mg/l.....	<.01
Stand Pipe, Silver City, J.V.	:	Magnesium as Mg, mg/l.....	36.2
COMMENTS:	:	Manganese as Mn, mg/l.....	<.01
.....	:	Mercury as Hg, mg/l.....	<.0002
PARAMETER	DETECTED	PARAMETER	DETECTED
Alkalinity as CaCO <sub>3</sub> , mg/l.....	108	Nickel as Ni, mg/l.....	<.01
Ammonia as NH <sub>3</sub> -N, mg/l.....	0.24	Nitrate as NO <sub>3</sub> -N, mg/l.....	1.29
Arsenic as As, mg/l.....	<.01	Nitrite as NO <sub>2</sub> -N, mg/l.....	<.005
Barium as Ba, mg/l.....	0.077	Phosphate as PO <sub>4</sub> -P, mg/l.....	<.01
Bicarbonate as HCO <sub>3</sub> , mg/l.....	132	Potassium as K, mg/l.....	4.0
Cadmium as Cd, mg/l.....	<.01	Selenium as Se, mg/l.....	<.005
Calcium as Ca, mg/l.....	52.7	Silica as SiO <sub>2</sub> (Diss), mg/l....	25.1
Carbonate as CO <sub>3</sub> , mg/l.....	0	Silver as Ag, mg/l.....	<.01
Chloride as Cl, mg/l.....	157	Sodium as Na, mg/l.....	53
Chromium as Cr (Hex), mg/l.....	<.01	Sulfate as SO <sub>4</sub> , mg/l.....	95
Chromium as Cr (Tot), mg/l.....	<.01	Total Dissolved Solids, mg/l..	579
Cyanide as CN, mg/l.....	<.002	Turbidity, NTU.....	0.2
		Zinc as Zn, mg/L.....	0.022
		pH Units.....	8.11
		Cation, meq/l.....	8.03
		Anions, meq/l.....	0.50

  
Rex Henderson



# CHEMTECH

CHEMICAL AND BACTERIOLOGICAL ANALYSES

 6100 S. STRATLER  
 MURRAY, UTAH 84107  
 (801) 262-7299

## CERTIFICATE OF ANALYSIS

### SAMPLE IDENTIFICATION

CLIENT: North Lily Mining

P.O. Box 421

Eureka, UT 84068

LAB NO: U044632

DATE SAMPLED: 9-13-89

TIME SAMPLED: @0600

SAMPLED BY: L. McNulty

LOCATION: Standpipe @ Storage  
Tank

### COMMENTS:

.....

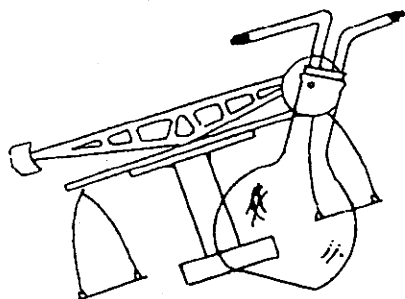
PARAMETER	DETECTED
Alkalinity as CaCO <sub>3</sub> , mg/l.....	135
Ammonia as NH <sub>3</sub> -N, mg/l.....	<.2
Arsenic as As, mg/l.....	<.01
Barium as Ba, mg/l.....	0.050
Bicarbonate as HCO <sub>3</sub> , mg/l.....	165
Cadmium as Cd, mg/l.....	<.01
Calcium as Ca, mg/l.....	49.6
Carbonate as CO <sub>3</sub> , mg/l.....	0
Chloride as Cl, mg/l.....	144
Chromium as Cr (Hex), mg/l.....	<.01
Chromium as Cr (Tot), mg/l.....	<.01
Cyanide as CN, mg/l.....	<.002

### PARAMETER

### DETECTED

Conductivity, umhos/cm.....	784
Copper as Cu, mg/l.....	0.015
Fluoride as F, mg/l.....	0.33
Hardness as CaCO <sub>3</sub> , mg/l.....	309
Hydroxide as OH, mg/l.....	0
Iron as Fe (Diss), mg/l.....	<.01
Iron as Fe (Tot), mg/l.....	0.105
Lead as Pb, mg/l.....	0.010
Magnesium as Mg, mg/l.....	53.7
Manganese as Mn, mg/l.....	<.01
Mercury as Hg, mg/l.....	<.0002
Nickel as Ni, mg/l.....	0.015
Nitrate as NO <sub>3</sub> -N, mg/l.....	1.04
Nitrite as NO <sub>2</sub> -N, mg/l.....	<.005
Phosphate as PO <sub>4</sub> -P, mg/l.....	0.012
Potassium as K, mg/l.....	3.3
Selenium as Se, mg/l.....	<.002
Silver as Ag, mg/l.....	<.01
Sodium as Na, mg/l.....	55.1
Sulfate as SO <sub>4</sub> , mg/l.....	103
Total Dissolved Solids, mg/l..	676
Turbidity, NTU.....	0.5
Zinc as Zn, mg/l.....	0.080
pH Units.....	7.98

Rex Henderson



# Ford Chemical

## LABORATORY, INC.

*Bacteriological and Chemical Analysis*

40 WEST LOUISE AVENUE  
SALT LAKE CITY, UTAH 84115

PHONE 466-8761

DATE: 10/14/81

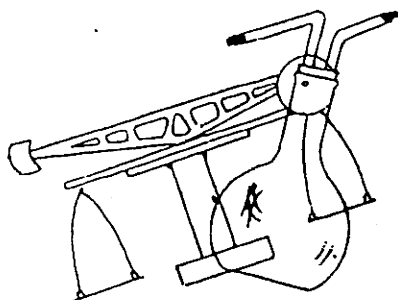
### CERTIFICATE OF ANALYSIS

WATER, WASTE & LAND  
1311 SO. COLLEGE AVE  
FORT COLLINS, CO  
80524

81-007350

SAMPLE: WATER SAMPLE FROM NORTH LILY WELL, EUREKA DATED 9-18-81  
RECEIVED 9-18-81 FOR COMPLETE ANALYSIS.

Alkalinity as CaCO <sub>3</sub> mg/l	114.00	Ammonia as NH <sub>3</sub> -N mg/l	<.01
Arsenic as As mg/l	.004	Barium as Ba mg/l	.065
Bicarbonate as HCO <sub>3</sub> mg/l	139.08	Boron as B mg/l	.020
Cadmium as Cd mg/l	<.001	Calcium as Ca mg/l	51.20
Carbonate as CO <sub>3</sub> mg/l	<.01	Chloride as Cl mg/l	114.00
Chromium as Cr (Hex.) mg/l	<.001	Chromium as Cr (Tot) mg/l	<.001
Conductivity umhos/cm	660	Copper as Cu mg/l	<.001
Fluoride as F mg/l	.28	Hardness as CaCO <sub>3</sub> mg/l	240
Hydroxide as OH mg/l	<.01	Iron as Fe (Dissolved) mg/l	.096
Iron as Fe (Total) mg/l	.150	Lead as Pb mg/l	<.001
Magnesium as Mg mg/l	26.88	Manganese as Mn mg/l	.010
Mercury as Hg mg/l	<.00020	Nickel as Ni mg/l	<.001
Nitrate as NO <sub>3</sub> -N mg/l	.88	Nitrite as NO <sub>2</sub> -N mg/l	.01
Phosphate PO <sub>4</sub> -P Ortho mg/l	.015	Potassium as K mg/l	10.20
Selenium as Se mg/l	<.001	Silica as SiO <sub>2</sub> Diss. Mg/l	25.00



# Ford Chemical

## LABORATORY, INC.

*Bacteriological and Chemical Analysis*

40 WEST LOUISE AVENUE  
SALT LAKE CITY, UTAH 84115

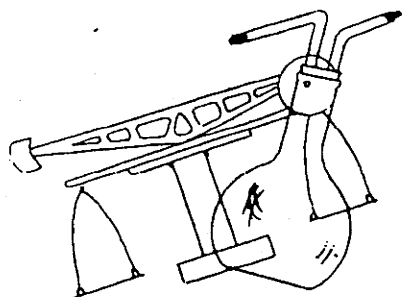
PHONE 466-8761

PAGE: 2

### CERTIFICATE OF ANALYSIS

Silver as Ag mg/l	<.001	Sodium as Na mg/l	42.00
Sulfate as SO <sub>4</sub> mg/l	67.5	Total Diss. Solids Mg/l	430
Turbidity NTU	.40	Zinc as Zn mg/l	.012
PH Units	8.10		

  
FORD CHEMICAL LABORATORY, INC.



# Ford Chemical

## LABORATORY, INC.

*Bacteriological and Chemical Analysis*

40 WEST LOUISE AVENUE  
SALT LAKE CITY, UTAH 84115

PHONE 466-8761

DATE: 10/14/81

CERTIFICATE OF ANALYSIS

81-007350-01

### FORD CHEMICAL LABORATORIES

#### BALANCE SHEET FOR SAMPLE: (1) RESULTS

##### CATIONS

	mg/l	meq/l
Calcium as Ca mg/l	51.200	2.555
Magnesium as Mg mg/l	26.880	2.211
Iron as Fe (Dissolved) mg/l	.096	.003
Sodium as Na mg/l	42.000	1.827
Potassium as K mg/l	10.200	.261

##### ANIONS

	mg/l	meq/l
Carbonate as CO <sub>3</sub> mg/l	.000	.000
Bicarbonate as HCO <sub>3</sub> mg/l	139.080	2.281
Sulfate as SO <sub>4</sub> mg/l	67.500	1.405
Chloride as Cl mg/l	114.000	3.216
Nitrate as NO <sub>3</sub> -N mg/l	.880	.014

#### BALANCE INFORMATION

CATIONS:	6.857
ANIONS:	6.916
TOTAL:	13.773
DIFFERENCE:	.059
SIGMA:	.004

### **Solution Pond Compaction Results Appendix**



<b>STEFFEN ROBERTSON &amp; KIRSTEN</b> Consulting Engineers	North Bay PROJECT FEATURE <u>SOLUTION Ponds (WEST)</u> TESTED BY _____ CHECKED BY _____ DATE <u>4/13/87</u> PAGE _____ OF _____
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**FIELD DENSITY TEST (NUCLEAR METHOD)**

TEST NO. (TO BE DETERMINED IN OFFICE)					
TIME OF TEST		1337			
LOCATION	A. GENERAL (AREA, STATION)	WEST POND	WEST POND	→	
	B. LOCAL (OFFSET, DIST.)	50' BEH 5' N of	40' BEH 40' E of	→	
ELEVATION		-4'			
MATERIAL TYPE					
CONTRACTOR					
MODE/DEPTH (BACKSCATTER, DIRECT TRANSMISSION)		12"	6"	12"	6"
DENSITY COUNT	Units	791	2971	856	3629
DENSITY COUNT RATIO					
WET DENSITY		115.2	121.9	113.3	113.2
MOISTURE COUNT		188	191	161	164
MOISTURE COUNT RATIO					
MOISTURE CONTENT (WEIGHT)		14.5			
DRY DENSITY		98	104.5	99.0	97.97
MOISTURE CONTENT		17.5	16.6	14.4	14.4
SAMPLE REFERENCE NO.				658	92
LAB REFERENCE				564	
ASTM DESIGNATION - D 698, D 1557 RAPID, D 4253 & D 4254				94	
METHOD: A, B, C, D				166	
LAB CYL. WET DENSITY OR REL. MINIMUM					
LAB MAX. WET DENSITY OR REL. MAXIMUM					
LAB OPTIMUM MOISTURE CONTENT		%			
LAB MAXIMUM DRY DENSITY					
"C" RATIO FLD. DEN./CLY. DEN.		%			
"D" RATIO FLD. DEN./MAX. DEN.		%			
MINIMUM SPECIFIED COMPACTION		%			
RETEST ? (IF YES, PLEASE INDICATE PREVIOUS TEST DATE AND TIME)					
REMARKS:		CONTRACTOR SCARLETT & REWORK			
GAGE MODEL NO. 3411B		GAGE SERIAL NO. 8597			
STANDARD COUNTS	DENSITY 2971	MOISTURE 586			

STEFFEN ROBERTSON &amp; KIRSTEN

Consulting Engineers

Northway PROJECT

FEATURE West Solution PondsTESTED BY D. R. R. R. CHECKED BY \_\_\_\_\_DATE 4/16 PAGE \_\_\_\_\_ OF \_\_\_\_\_

## FIELD DENSITY TEST (NUCLEAR METHOD)

TEST NO. (TO BE DETERMINED IN OFFICE)		16-1	16-2	16-3	16-4	16-5
TIME OF TEST						
LOCATION	A. GENERAL (AREA, STATION)	W. BEAR W. Pond		W. B. W. P.	W. C. L. R.	So. B. R. R.
	B. LOCAL (OFFSET, DIST.)	50' SO 12' W. L.		50' N. 50' E.	5 W - E	W. POND 30' E. L. W. E. L.
ELEVATION		- 48		- 5	- 6	- 4
MATERIAL TYPE						
CONTRACTOR						
MODE/DEPTH (BACKSCATTER, DIRECT TRANSMISSION)		12"	12"	12"	12"	2"
DENSITY COUNT	Units	652	640	577	667	630
DENSITY COUNT RATIO						
WET DENSITY		121	122	125.1	121	123
MOISTURE COUNT		160	166	200	175	184
MOISTURE COUNT RATIO						
MOISTURE CONTENT (WEIGHT)						
DRY DENSITY		107	105	104	102	104.2
MOISTURE CONTENT		% 15.8	16	19.7	17.7	18.0
SAMPLE REFERENCE NO.						
LAB REFERENCE						
ASTM DESIGNATION - D698, D1557 RAPID, D4253 & D4254						
METHOD: A, B, C, D						
LAB CYL. WET DENSITY OR REL. MINIMUM						
LAB MAX. WET DENSITY OR REL. MAXIMUM						
LAB OPTIMUM MOISTURE CONTENT		%				
LAB MAXIMUM DRY DENSITY						
"C" RATIO FLD. DEN. / CLY. DEN.		%				
"D" RATIO FLD. DEN. / MAX. DEN.		%				
MINIMUM SPECIFIED COMPACTION		%				
RETEST ? (IF YES, PLEASE INDICATE PREVIOUS TEST DATE AND TIME)					RETEST	
REMARKS:						
GAGE MODEL NO. <u>3411 B</u>		GAGE SERIAL NO. <u>8597</u>				
STANDARD COUNTS	DENSITY <u>2965</u>	MOISTURE <u>581</u>				

STEFFEN ROBERTSON &amp; KIRSTEN

Consulting Engineers

North Bay PROJECT

FEATURE Suburban Roads

TESTED BY

CHECKED BY

DATE 4/26

PAGE \_\_\_\_\_ OF \_\_\_\_\_

## FIELD DENSITY TEST (NUCLEAR METHOD)

TEST NO. (TO BE DETERMINED IN OFFICE)						
TIME OF TEST		16 <sup>45</sup>	17 <sup>00</sup>	17 <sup>15</sup>	17 <sup>20</sup>	17 <sup>22</sup>
LOCATION	A. GENERAL (AREA, STATION)	W BERR W 20+12	50 BERR W 20+12	W BERR W 20+12	EAST PAD BERR	EAST BERR PAD
	B. LOCAL (OFFSET, DIST.)	30' N. SW COR.	50' E SW COR.	4x6 SW COR.	100' SO CROSS	3+005 E
ELEVATION		-3 <sup>2</sup>	-2 <sup>2</sup>	-1 <sup>0</sup>	-0 <sup>27</sup>	-1 <sup>2</sup>
MATERIAL TYPE						
CONTRACTOR						
MODE/DEPTH (BACKSCATTER, DIRECT TRANSMISSION)		12"				
DENSITY COUNT	Units	486	447	514	479	610
DENSITY COUNT RATIO						
<del>WET DENSITY</del>		<del>129.6</del>	<del>132.1</del>	<del>127.5</del>	<del>130.0</del>	<del>122.6</del>
MOISTURE COUNT		199	202	185	180	193
MOISTURE COUNT RATIO						
MOISTURE CONTENT (WEIGHT)						
DRY DENSITY		109.4	111.6	109.2	111.9	103.1
<del>MOISTURE CONTENT</del>		<del>18.5</del>	<del>18.4</del>	<del>17.2</del>	<del>16.3</del>	<del>18.9</del>
SAMPLE REFERENCE NO.						
LAB REFERENCE						
ASTM DESIGNATION - D698, D1557 RAPID, D4253 & D4254						
METHOD: A, B, C, D						
LAB CYL. WET DENSITY OR REL. MINIMUM						
LAB MAX. WET DENSITY OR REL. MAXIMUM						
LAB OPTIMUM MOISTURE CONTENT		%				
LAB MAXIMUM DRY DENSITY						
"C" RATIO	FLD. DEN. / CLY. DEN.	%	100T	100T	100T	94.18
"D" RATIO	FLD. DEN. / MAX. DEN.	%				
MINIMUM SPECIFIED COMPACTION		%				
RETEST ? (IF YES, PLEASE INDICATE PREVIOUS TEST DATE AND TIME)						
REMARKS:					ONLY 250' CONTRACT.	
GAGE MODEL NO. <u>3411 B</u>		GAGE SERIAL NO. <u>6597</u>				
STANDARD COUNTS	DENSITY <u>2893</u>	MOISTURE <u>503</u>				



## STEFFEN ROBERTSON &amp; KIRSTEN

Consulting Engineers

North City PROJECT

FEATURE Solution Roads

DATE OF SUMMARY \_\_\_\_\_ TO \_\_\_\_\_

PAGE \_\_\_\_\_ OF \_\_\_\_\_

## SUMMARY OF FIELD TEST ON COMPACTED FILL

TYPE OF FIELD TEST \_\_\_\_\_

MATERIAL TYPE \_\_\_\_\_

DATE	TIME	LOCATION A B	DEPTH ELEV.	SAMPLE NO.	% PLUS 3/4"	Y <sub>w</sub> fill	F.M.C.	DRY DENSITY (PCF)			OMC %	OMC- F.M.C.	'C' RATIO	'D' RATIO	MOVING AVG.
								Y <sub>d</sub> fill	Y <sub>d</sub> clay	Y <sub>d</sub> max					
4/16	1220	Retest 16.4	-6°			127.9	19.3	107.1		110	15				
		West Berm West Pond 15.5 Nide Q+ Is F	-2°			131.3	17.9	111.4							
	1345	N-5 C Face	-3.5			125.0	17.2	106.6							
	1349	SW Caw C Face So	-5°			124.7	17.2	106.4							
		50' 50" WP 12' WE	-4°			121	15.8	107							
		16.2				122	16	105							
		50' N WP So E	-5.5			125.1	19.7	104							
		SW Wbr - E	-6°			121	17.7	102							
		W Pond Berm 30' E E West E	-4°			123	18.0	104.2							

REMARKS \_\_\_\_\_

## STEFFEN ROBERTSON &amp; KIRSTEN

Consulting Engineers

North Lily PROJECT

FEATURE Solution Ponds

DATE OF SUMMARY \_\_\_\_\_ TO \_\_\_\_\_

PAGE \_\_\_\_\_ OF \_\_\_\_\_

## SUMMARY OF FIELD TEST ON COMPACTED FILL

## TYPE OF FIELD TEST

MATERIAL TYPE \_\_\_\_\_

DATE	TIME	LOCATION A B	DEPTH ELEV.	SAMPLE NO.	% PLUS 3/4"	Y <sub>w</sub> fill	F.M.C.	DRY DENSITY (PCF)			OMC %	OMC- F.M.C.	'C' RATIO	'D' RATIO	MOVING AVG.
								Y <sub>d</sub> fill	Y <sub>d</sub> clay	Y <sub>d</sub> max					
4/15	1140	West Pond West Berm 20' S 1.15	-2.5			116	19.7	97		110	15.5				
		Re-cast 1.15				116.9	14.7	101							
						116.0	16.3	99							
						116.1	16.5	99.6							
						127.6	16.0	116							
						115.2	17.5	98							
4/13	1337	West Pond S Berm - 5' No E	12"			121.9	16.6	104.5							
		West Pond N Berm - 40' E W E	6"			113.3	14.4	99.0							
		"	12"			1132	14.4	97							
			6"												

REMARKS \_\_\_\_\_

STEFFEN ROBERTSON &amp; KIRSTEN

Consulting Engineers

North Lily PROJECT

FEATURE

SOLUTION ROAD

TESTED BY

D. ROBERTSON

CHECKED BY

DATE

4/16/84

PAGE

OF

## FIELD DENSITY TEST (NUCLEAR METHOD)

TEST NO. (TO BE DETERMINED IN OFFICE)		16-4	16-5	16-6	16-7
TIME OF TEST		12:20	13:41	13:45	13:49
LOCATION	A. GENERAL (AREA, STATION)	R2-155	WEST 8th	-	-
	B. LOCAL (OFFSET, DIST.)	16-4	WEST 100ft	-	-
ELEVATION		-6'	-2'	-3'	-5'
MATERIAL TYPE					
CONTRACTOR					
MODE/DEPTH (BACKSCATTER, DIRECT TRANSMISSION)		12"	12"	12"	12"
DENSITY COUNT	Units	528	473	581	588
DENSITY COUNT RATIO					
WET DENSITY		127.9	131.3	125.0	124.7
MOISTURE COUNT		202	194	180	179
MOISTURE COUNT RATIO					
MOISTURE CONTENT (WEIGHT)					
DRY DENSITY		107.1	111.4	106.6	106.4
MOISTURE CONTENT		19.3	17.9	17.2	17.2
SAMPLE REFERENCE NO.					
LAB REFERENCE					
ASTM DESIGNATION - D698, D1557 RAPID, D4253 & D4254					
METHOD: A, B, C, D					
LAB CYL. WET DENSITY OR REL. MINIMUM					
LAB MAX. WET DENSITY OR REL. MAXIMUM					
LAB OPTIMUM MOISTURE CONTENT					
LAB MAXIMUM DRY DENSITY					
"C" RATIO FLD. DEN. / CLY. DEN.					
"D" RATIO FLD. DEN. / MAX. DEN.					
MINIMUM SPECIFIED COMPACTION					
RETEST ? (IF YES, PLEASE INDICATE PREVIOUS TEST DATE AND TIME)					
REMARKS:					
GAGE MODEL NO.		3411B		GAGE SERIAL NO.	
				8597	
STANDARD COUNTS		2969		MOISTURE	
				581	

STEFFEN ROBERTSON &amp; KIRSTEN

Consulting Engineers

North Lily PROJECT

FEATURE SOLUTION ROADTESTED BY D. R. R. R. CHECKED BY \_\_\_\_\_DATE 4/15/88 PAGE \_\_\_\_\_ OF \_\_\_\_\_

## FIELD DENSITY TEST (NUCLEAR METHOD)

TEST NO. (TO BE DETERMINED IN OFFICE)		1-15	1-15	1-15	1-15	1-15
TIME OF TEST		11:41				13:27
LOCATION	A. GENERAL (AREA, STATION)	WEST SOL POND	RETESTS			
	B. LOCAL (OFFSET, DIST.)	WEST SOL 20' SO				
ELEVATION		-2.5				
MATERIAL TYPE						
CONTRACTOR		GRAN				
MODE/DEPTH (BACKSCATTER, DIRECT TRANSMISSION)		12			6"	6'12"
DENSITY COUNT	Units	781	755	784	3403	2614
DENSITY COUNT RATIO						
WET DENSITY		116	116.5	116.0	116.1	126
MOISTURE COUNT		155	155	151	153	193
MOISTURE COUNT RATIO						
MOISTURE CONTENT (WEIGHT)						
DRY DENSITY		97	108	99	99.6	110
MOISTURE CONTENT		18.7	10.7	16.3	16.5	16.0
SAMPLE REFERENCE NO.			314.8			
LAB REFERENCE			274.4		14.7	
ASTM DESIGNATION - D 698, D 1557 RAPID, D 4253 & D 4254			404			
METHOD: A, B, C, D			14.7		101	
LAB CYL. WET DENSITY OR REL. MINIMUM			ACF			
LAB MAX. WET DENSITY OR REL. MAXIMUM						
LAB OPTIMUM MOISTURE CONTENT						
LAB MAXIMUM DRY DENSITY						
"C" RATIO FLD. DEN. / CLY. DEN.						
"D" RATIO FLD. DEN. / MAX. DEN.						
MINIMUM SPECIFIED COMPACTION					93%	
RETEST ? (IF YES, PLEASE INDICATE PREVIOUS TEST DATE AND TIME)						
REMARKS:		CONTRACTOR HAD TO REWORK WITH APPROPRIATE MOISTURE ROLLING				
GAGE MODEL NO.		3411 B		GAGE SERIAL NO. 8597		
STANDARD COUNTS	DENSITY	2957		MOISTURE 579		



## STEFFEN ROBERTSON &amp; KIRSTEN

Consulting Engineers

North Lily PROJECT

FEATURE Solution Ponds

DATE OF SUMMARY \_\_\_\_\_ TO \_\_\_\_\_

PAGE \_\_\_\_\_ OF \_\_\_\_\_

## SUMMARY OF FIELD TEST ON COMPACTED FILL

## TYPE OF FIELD TEST

MATERIAL TYPE \_\_\_\_\_

DATE	TIME	LOCATION A B	DEPTH ELEV.	SAMPLE NO.	% PLUS 3/4"	Y <sub>w</sub> fill	F.M.C.	DRY DENSITY (PCF)			OMC %	OMC- EMC.	'C' RATIO	'D' RATIO	MOVING AVG.
								Y <sub>d</sub> fill	Y <sub>d</sub> clay	Y <sub>d</sub> max					
4/5	1140	West Pond West Berm 20' S 1.15	-2.5			116	19.7	97		110	15.5				
		Retest 1.15				116.9	14.7	101							
						116.0	16.3	99							
						116.1	16.5	99.6							
						127.6	16.0	110							
						115.2	17.5	98							
4/13	1337	West Pond S Berm - 5' NE	12"			121.9	16.6	104.5							
		West Pond N Berm - 40' E NE	6"			1133	14.4	99.0							
		"	12"			1132	14.4	97							
			6"												

REMARKS \_\_\_\_\_

## STEFFEN ROBERTSON &amp; KIRSTEN

Consulting Engineers

North L-14 PROJECT

FEATURE Solute Road

DATE OF SUMMARY \_\_\_\_\_ TO \_\_\_\_\_

PAGE \_\_\_\_\_ OF \_\_\_\_\_

## SUMMARY OF FIELD TEST ON COMPACTED FILL

## TYPE OF FIELD TEST

MATERIAL TYPE \_\_\_\_\_

DATE	TIME	LOCATION A B	DEPTH ELEV.	SAMPLE NO.	% PLUS 3/4"	Y <sub>w</sub> fill	F.M.C.	DRY DENSITY (PCF)			OMC %	OMC- F.M.C.	'C' RATIO	'D' RATIO	MOVING AVG.
								Y <sub>d</sub> fill	Y <sub>d</sub> clay	Y <sub>d</sub> max					
4/16	1220	Rtctst 16.4	-6.0			127.9	19.3	107.1		110	15				
	1341	West Berm West Pond 15.5 N.E. At Is. E	-2.0			131.3	17.9	111.4							
	1345	N-5 C.C. Face	-3.5			125.0	17.2	106.6							
	1349	SW Caw C.N. Face 50	-5.0			124.7	17.2	106.4							
		50' 50' WB 12' W E	-4.0			121	15.8	107							
		16.2				122	16	105							
		50' N WB 50' E	-5.5			125.1	19.7	104							
		SW W. W. W. - E	-6.0			121	17.7	102							
		W Pond Berm 30' E E West E	-4.0			123	18.0	104.2							

REMARKS \_\_\_\_\_



STEFFEN ROBERTSON &amp; KIRSTEN

Consulting Engineers

North Bay PROJECT

FEATURE Solution Ponds

TESTED BY \_\_\_\_\_

CHECKED BY \_\_\_\_\_

DATE 4/26

PAGE \_\_\_\_\_ OF \_\_\_\_\_

## FIELD DENSITY TEST (NUCLEAR METHOD)

TEST NO. (TO BE DETERMINED IN OFFICE)						
TIME OF TEST		16 <sup>45</sup>	17 <sup>00</sup>	17 <sup>15</sup>	17 <sup>20</sup>	17 <sup>22</sup>
LOCATION	A. GENERAL (AREA, STATION)	W BERM W POND	50 BEM W POND	W BERM W POND	EAST PAID BERM	EAST BERM POND
	B. LOCAL (OFFSET, DIST.)	30' W. SW CORN.	50' E SW CORN.	EXC SW CORN.	1550 SO CUBIT	3+005 E
ELEVATION		-3'	-2'	-1'	-0'	-1'
MATERIAL TYPE						
CONTRACTOR						
MODE/DEPTH (BACKSCATTER, DIRECT TRANSMISSION)		12"				
DENSITY COUNT	Units	486	447	514	479	610
DENSITY COUNT RATIO						
<del>WET DENSITY</del>		129.6	137.1	127.5	134.2	122.6
MOISTURE COUNT		199	202	185	180	193
MOISTURE COUNT RATIO						
MOISTURE CONTENT (WEIGHT)						
DRY DENSITY		109.4	111.6	109.2	111.9	103.1
<del>MOISTURE CONTENT</del>		18.5	18.4	17.2	16.3	18.9
SAMPLE REFERENCE NO.						
LAB REFERENCE						
ASTM DESIGNATION - D698, D1557 RAPID, D4253 & D4254						
METHOD: A, B, C, D						
LAB CYL. WET DENSITY OR REL. MINIMUM						
LAB MAX. WET DENSITY OR REL. MAXIMUM						
LAB OPTIMUM MOISTURE CONTENT		%				
LAB MAXIMUM DRY DENSITY						
"C" RATIO	FLD. DEN. / CLY. DEN.	%	100%	100%	100%	94.4%
"D" RATIO	FLD. DEN. / MAX. DEN.	%				
MINIMUM SPECIFIED COMPACTION		%				
RETEST ? (IF YES, PLEASE INDICATE PREVIOUS TEST DATE AND TIME)						
REMARKS:					ONLY 250' CONTRACT.	
GAGE MODEL NO. <u>3411 B</u>		GAGE SERIAL NO. <u>8597</u>				
STANDARD COUNTS	DENSITY <u>2893</u>	MOISTURE <u>583</u>				

STEFFEN ROBERTSON &amp; KIRSTEN

Consulting Engineers

NORTH HAVEN PROJECT

FEATURE West Solution Pond  
TESTED BY D. R. R. R. CHECKED BY \_\_\_\_\_  
DATE 4/16 PAGE \_\_\_\_\_ OF \_\_\_\_\_

## FIELD DENSITY TEST (NUCLEAR METHOD)

TEST NO. (TO BE DETERMINED IN OFFICE)		16-1	16-2	16-3	16-4	16-5
TIME OF TEST						
LOCATION	A. GENERAL (AREA, STATION)	W. BRAN W. Pond		W. P W. P	W. COW W. COW	SO BRAN
	B. LOCAL (OFFSET, DIST.)	50' SO 11' W. E.		50' N. 50' E.	SW - E	W. Pond 30' E. (E) W. E. E.
ELEVATION		- 48		- 5	- 6	- 4
MATERIAL TYPE						
CONTRACTOR						
MODE/DEPTH (BACKSCATTER, DIRECT TRANSMISSION)		12"	12"	12"	12"	2"
DENSITY COUNT	Units	652	644	577	662	630
DENSITY COUNT RATIO						
WET DENSITY		121	122	125.1	121	123
MOISTURE COUNT		160	166	200	175	184
MOISTURE COUNT RATIO						
MOISTURE CONTENT (WEIGHT)						
DRY DENSITY		107	105	104	102	104
MOISTURE CONTENT		15.8	16	19.7	17.7	18.0
SAMPLE REFERENCE NO.						
LAB REFERENCE						
ASTM DESIGNATION - D698, D1557 RAPID, D4253 & D4254						
METHOD: A, B, C, D						
LAB CYL. WET DENSITY OR REL. MINIMUM						
LAB MAX. WET DENSITY OR REL. MAXIMUM						
LAB OPTIMUM MOISTURE CONTENT		%				
LAB MAXIMUM DRY DENSITY						
"C" RATIO FLD. DEN. / CLY. DEN.		%				
"D" RATIO FLD. DEN. / MAX. DEN.		%				
MINIMUM SPECIFIED COMPACTION		%				
RETEST ? (IF YES, PLEASE INDICATE PREVIOUS TEST DATE AND TIME)						RETEST
REMARKS:						
GAGE MODEL NO. 3411 B		GAGE SERIAL NO. 8597				
STANDARD COUNTS	DENSITY 2965	MOISTURE 581				

STEFFEN ROBERTSON &amp; KIRSTEN

Consulting Engineers

North Lily PROJECT

FEATURE

SOLUTION POND

TESTED BY

P. RANNEY

CHECKED BY

DATE

4/16/81

PAGE

OF

## FIELD DENSITY TEST (NUCLEAR METHOD)

TEST NO. (TO BE DETERMINED IN OFFICE)		16-4	16-5	16-6	16-7
TIME OF TEST		12:20	13:41	13:45	13:49
LOCATION	A. GENERAL (AREA, STATION)	RETEST 16-4	WEST BR WEST POND	-	-
	B. LOCAL (OFFSET, DIST.)		15'S NO 4 AT ISF	N-5 4 CRANE	S W Gate SW FACE
ELEVATION		-6'	-2'	-3'	-5'
MATERIAL TYPE					
CONTRACTOR					
MODE/DEPTH (BACKSCATTER, DIRECT TRANSMISSION)		12"	12"	12"	12"
DENSITY COUNT	Units	528	473	581	588
DENSITY COUNT RATIO					
WET DENSITY		127.9	131.3	125.0	124.7
MOISTURE COUNT		202	194	180	179
MOISTURE COUNT RATIO					
MOISTURE CONTENT (WEIGHT)					
DRY DENSITY		107.1	111.4	106.6	106.4
MOISTURE CONTENT		19.3	17.9	17.2	17.2
SAMPLE REFERENCE NO.					
LAB REFERENCE					
ASTM DESIGNATION - D698, D1557 RAPID, D4253 & D4254					
METHOD: A, B, C, D					
LAB CYL. WET DENSITY OR REL. MINIMUM					
LAB MAX. WET DENSITY OR REL. MAXIMUM					
LAB OPTIMUM MOISTURE CONTENT					
LAB MAXIMUM DRY DENSITY					
"C" RATIO FLD. DEN. / CLY. DEN.					
"D" RATIO FLD. DEN. / MAX. DEN.					
MINIMUM SPECIFIED COMPACTION					
RETEST ? (IF YES, PLEASE INDICATE PREVIOUS TEST DATE AND TIME)					
REMARKS:					
GAGE MODEL NO.		3411R			
GAGE SERIAL NO.		8597			
STANDARD COUNTS	DENSITY	2969			
	MOISTURE	581			

STEFFEN ROBERTSON &amp; KIRSTEN

Consulting Engineers

North /uy PROJECT

FEATURE

Solution Roads

TESTED BY

J. Rouse

CHECKED BY

DATE

4/15/88

PAGE

OF

## FIELD DENSITY TEST (NUCLEAR METHOD)

TEST NO. (TO BE DETERMINED IN OFFICE)		1-15	1-15	1-15	1/15	1-15
TIME OF TEST		11:41				13:27
LOCATION	A. GENERAL (AREA, STATION)	WEST 50L POND				
	B. LOCAL (OFFSET, DIST.)	WEST 80L 20'50"				Reloc 20
ELEVATION		-2.5				
MATERIAL TYPE						
CONTRACTOR		Graham				
MODE/DEPTH (BACKSCATTER, DIRECT TRANSMISSION)		121			6"	6'12"
DENSITY COUNT	Units	781	755	784	3403	2614
DENSITY COUNT RATIO						
WET DENSITY		116	116.5	116.0	116.1	1226
MOISTURE COUNT		155	155	151	153	193
MOISTURE COUNT RATIO						
MOISTURE CONTENT (WEIGHT)						
DRY DENSITY		97	102	99	99.6	110
MOISTURE CONTENT		19.7	10.7	16.3	16.5	16.0
SAMPLE REFERENCE NO.			314.8			
LAB REFERENCE			274.4		14.7	
ASTM DESIGNATION - D698, D1557 RAPID, D4253 & D4254			404			
METHOD: A, B, C, D			14.7		101	
LAB CYL. WET DENSITY OR REL. MINIMUM			105			
LAB MAX. WET DENSITY OR REL. MAXIMUM						
LAB OPTIMUM MOISTURE CONTENT						
LAB MAXIMUM DRY DENSITY						
"C" RATIO FLD. DEN. / CLY. DEN.						
"D" RATIO FLD. DEN. / MAX. DEN.						
MINIMUM SPECIFIED COMPACTION						93%
RETEST ? (IF YES, PLEASE INDICATE PREVIOUS TEST DATE AND TIME)						
REMARKS:		CONTRACTOR HAD MOISTURE TYPICAL WITH APPROX MOISTURE: 16.5%				
GAGE MODEL NO.		3411 B	GAGE SERIAL NO. 8597			
STANDARD COUNTS	DENSITY	2957	MOISTURE 579			

STEFFEN ROBERTSON &amp; KIRSTEN

Consulting Engineers

North Long PROJECT

FEATURE

SOLUTION ROAD (WEST)

TESTED BY

CHECKED BY

DATE

4/13/87

PAGE

OF

## FIELD DENSITY TEST (NUCLEAR METHOD)

TEST NO. (TO BE DETERMINED IN OFFICE)					
TIME OF TEST		1337			
LOCATION	A. GENERAL (AREA, STATION)	WEST POINT	WEST POINT	→	
	B. LOCAL (OFFSET, DIST.)	50' BEH 5' 16" E	40' BEH 40' E W	→	
ELEVATION		-4'			
MATERIAL TYPE					
CONTRACTOR					
MODE/DEPTH (BACKSCATTER, DIRECT TRANSMISSION)		12"	6"	12"	6"
DENSITY COUNT	Units	788	2971	856	3629
DENSITY COUNT RATIO					
WET DENSITY		115.2	121.9	113.3	113.2
MOISTURE COUNT		188	191	161	164
MOISTURE COUNT RATIO					
MOISTURE CONTENT (WEIGHT)		14.5			
DRY DENSITY		98	104.5	99.0	97.9
MOISTURE CONTENT		17.5	16.6	14.4	14.4
SAMPLE REFERENCE NO.				658	97
LAB REFERENCE				564	
ASTM DESIGNATION - D698, D1557 RAPID, D4253 & D4254				94	
METHOD: A, B, C, D				166	
LAB CYL. WET DENSITY OR REL. MINIMUM					
LAB MAX. WET DENSITY OR REL. MAXIMUM					
LAB OPTIMUM MOISTURE CONTENT		%			
LAB MAXIMUM DRY DENSITY					
"C" RATIO FLD. DEN. / CLY. DEN.		%			
"D" RATIO FLD. DEN. / MAX. DEN.		%			
MINIMUM SPECIFIED COMPACTION		%			
RETEST ? (IF YES, PLEASE INDICATE PREVIOUS TEST DATE AND TIME)					
REMARKS:		CONTRACTOR SCRAPING & REWORK			
GAGE MODEL NO.		3411B	GAGE SERIAL NO.		8597
STANDARD COUNTS	DENSITY	2971	MOISTURE		586



# Environmental Management Services Company

## Company Profile

Environmental Management Services Company (EMS) is an independent privately owned professional services company located in Fort Collins, Colorado. The firm specializes in providing environmental permitting, regulatory compliance and related services to the mining industry. Since the firm's founding in 1980, EMS has provided a wide range of services on over 400 exploration, mine development, mine closure and mining related CERCLA site projects. EMS has experience with base and precious metal mines, coal mines and processing facilities, silica sand, sulfur, aggregate and other industrial mineral developments, and diamond projects located throughout the United States. The firm has extensive experience in underground and open-pit mining with recovery of contained values by heap and vat leach, flotation, and gravity methods.

EMS has assisted clients with properties located on fee, state and federal lands administered by the U.S. Forest Service, Bureau of Land Management and the U.S. Park Service. EMS has worked in a variety of sensitive environments, including the west side of the Cascades, the Mother Lode and Desert Conservation areas of California, and within or immediately adjacent to wilderness, wildlife refuges, wild and scenic river corridors, national parks and other environmentally sensitive areas. Representative services that EMS has provided to the mining industry are listed below.

- Pre-acquisition Evaluations and Due Diligence Assessments
- Preparation of the Environmental Sections of Financing Documents
- Mineral Exploration Permitting
- Permit Strategy Planning
- Resource Data Evaluations
- Baseline Study Design and Management
- Complete Mine Permitting
- Closure and Reclamation Planning
- Environmental Report and Impact Statement Preparation
- Regulatory Compliance Audits
- Environmental Hazard and Liability Assessment
- Superfund Technical and Administrative Services
- Litigation Support and Insurance Recovery

Increasingly our practice has been directed toward technical document preparation and review as well as litigation support associated with abandoned mine sites for which hazardous waste cleanup enforcement actions are being considered or have been initiated. Some of our representative project assignments in the area of abandoned and/or hazardous waste sites are summarized following.

**Rico Mining District, Colorado** - Project responsibilities for this multi-site Colorado Voluntary Clean-up program included research and preparation of a chronological history at the site, preparation of a permitting strategy and obtaining all necessary permits and regulatory approvals. Applications were prepared under the COE 404 program, Forest Service special use and

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**EMS**

conditional use regulations; Colorado Stormwater Management Program; and Water Discharge permitting programs.

**Almaden Quicksilver County Park Project** - A party who reportedly had conducted exploration operations at this historic mercury mining and processing site retained EMS as an expert witness. The property is currently Santa Clara County's second largest park and the property is listed under the California Superfund Program for wastes containing mercury that present human and ecological risks. EMS reviewed historical documents regarding operations at the park and the activities of our client along with the various risk assessments, remedial investigations and the Remedial Action Plan and ROD. Our analysis resulted in our client being regarded as a de minimus party and our work served as a foundation for a favorable settlement prior to the scheduled trial.

**Summitville Project, Colorado** - As the technical representative of a respondent, EMS's responsibilities at this CERCLA site included research and preparation of the respondent's chronological history at the site, review of the site's current status and preparation of comments for the Administrative Record regarding EPA's proposed and actual clean up efforts at the site.

**Caney Project** - EMS is the named Project Coordinator in the Administrative Order on Consent (AOC) for this CERCLA action being conducted at a former zinc smelter site located in Kansas. The action includes site characterization and preparation of streamlined risk assessments and an Engineering Evaluation and Cost Analysis (EE/CA) for a removal action directed at smelter debris and contaminated residential yard soils. The site is challenging because a high school has been constructed on the former smelter site.

**Dumus Project** - EMS is named as the Facility Coordinator in the Order with the Texas Natural Resources Conservation Commission (TNRCC) for a former zinc smelter located in north central Texas. Actions at this site have included site characterization investigations and preparation of a Remedial Investigation (RI) report, Risk assessments and other required deliverables. This site is removed from residential developments and accordingly, ecological risks have taken on great importance to TNRCC.

**Elkhorn Project** - EMS completed several pre-acquisition due diligence studies of active cyanide heap-leach operations including operating and closure plan enhancements for this historic gold property located in central Montana. The work included coordination with the Montana Abandoned Mine Land Program and preparation of all necessary exploration permits and development of a production permitting strategy.

**Jasper County Project** - EMS is the named Project Coordinator for this CERCLA action being conducted at one of the largest former mining and smelting sites in the United States. EMS has been intimately involved with the preparation of the RI and the risk assessments for this site. EPA has divided the action into four operable units. Records of Decisions (RODs) have been issued on three of these units. Two of the four units address contaminated residential yard soils and EMS has been involved in the oversight of both time-critical removal actions and remedial actions taken on residential yard soils at the site.

**Champaign Creek Mine Project** - EMS, as environmental project manager, was responsible for pre-acquisition due diligence, exploration permitting and reclamation and development of the production permitting strategy for this heap leach gold project located in eastern Idaho. We later

assisted in the transfer of the property and it's removal from the CERCLIS list of potentially Hazardous Waste Sites by successful development of remedial measures.

**Silver City Heap Leach Project** - EMS developed the facilities' heap leach closure plan that included existing permit review, and revisions to groundwater quality permit and reclamation plan for this Utah facility.

**Cherokee County Project** - EMS is the named Project Coordinator in the AOC for this CERCLA action being performed at former mining and lead smelter sites located in southeastern Kansas. The EPA has divided this site into seven sub-sites and to date RODs have been issued for three of these sub-sites. The other four sub-sites are currently being addressed under a focused RI with the presumed remedy approach developed by EMS.

**Revenue-Virginus Mine Project** - The EMS work included environmental review, permit preparation and defense in support of this major underground exploration mine located near Ouray, Colorado. A Colorado 110 mining permit was updated and transferred; a Construction Dewatering Storm Water Permit was obtained, maintained and closed; a mining Storm Water Permit was prepared along with a CDPS (NPDES) Permit.

**Newton County Project** - EMS is the named Project Coordinator in the AOC for this voluntary CERCLA action being taken to address potential risks from contaminated ground water and residential yard soils. Activities performed to date have included the characterization of drinking water supplies and residential yard soils and selection of a contractor to perform a time-critical yard soil removal action. After completion of the time critical EE/CA removal actions, attention will be directed toward on drinking water and additional residential yard soils.

**Eagle Mine Project** - EMS conducted a technical review of remedial investigations and feasibility studies of this Superfund mining site located in Eagle County, Colorado. EMS was responsible for review of all aspects of EPA's action.

**Tar Creek Project** - EMS was retained by five Potentially Responsible Parties (PRPs) for the Tar Creek Superfund Site to review and comment on actions performed by EPA and to coordinate other investigations performed for the PRPs to refute EPA's need to take action. These investigations included geochemical analyses of the lead in residential yard soils, which indicated that the primary source of lead in soil was lead-based paint; and a Community Health and Monitoring Plan (CHAMP) to demonstrate that residential yard soils did not have to be remediated to sufficiently reduce any identified elevated child blood lead levels.

**Red Cliff Project** - EMS conducted an environmental review and prepared necessary permits in support of this major underground exploration mine located within five miles of Vail, Colorado. Colorado and Eagle County exploration and 110 mining permits in addition to Colorado air and water quality permits were prepared. Upon completion of the exploration and mining activities, final reclamation for the site was negotiated, supervised and a bond release strategy developed. The reclaimed site won the Governor's Award due to innovative slope stabilization techniques.

**Zaca Project** - EMS was retained to prepare a Voluntary Remedial Measures Plan proposal to the Lahontan Regional Water Quality Control Board addressing historic acid mine drainage from several adits to the Carson River. The plan formed the basis for a settlement framework. The property owner, the Forest Service, and the RWQB are addressing the site jointly as a CERCLA action. EMS is responsible for the technical aspects of the EE/CA removal action.

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**EMS**

## **Thomas E. Gast**

### ***Principal***

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#### **PROFESSIONAL BACKGROUND**

Extensive experience as Project Manager in all phases of multi-disciplinary programs. Extensive experience with mining site cleanups including CERCLA, voluntary cleanups, AML and watershed restorations. Authored or co-authored over 40 NEPA documents for projects located on BLM, Forest Service, and Parks Service lands. Extensive knowledge, preparation, and defense of Federal, state, and local permits for land exchange, water development, and mining projects throughout the Western United States. Mine permitting experience includes: surface and underground mines; cyanidation, flotation, and gravity separation mills; precious metals refining processes; and various industrial mineral mines, mills, and quarries. Conducted over 150 due diligence and pre-acquisition studies.

#### **PROJECT EXPERIENCE**

**Summitville Project, Colorado.** As the technical representative of a respondent, responsibilities at this CERCLA site included research and preparation of the respondent's chronological history, review of the site's current status, and preparation of comments for the Administrative Record regarding EPA's proposed and actual cleanup efforts at the site.

**Almaden Quicksilver County Park Project, California.** A party who reportedly had conducted exploration operations at this historic mercury mining and processing site retained Mr. Gast as an expert witness. The property is currently Santa Clara County's second largest park and the property is listed under the California Superfund Program for wastes containing mercury that present human and ecological risks. The work included review of historical documents regarding operations at the park and the activities of our client along with the various risk assessments, remedial investigations and the Remedial Action Plan and ROD. The analysis resulted in our client being regarded as a de minimus party and the work served as a foundation for a favorable settlement prior to the scheduled trial.

**Rico Mining District, Colorado.** Project responsibilities for this multi-site Colorado Voluntary Cleanup program included preparing a permitting strategy and obtaining all necessary permits and regulatory approvals. Applications were prepared under the COE 404 program, Forest Service special use and conditional use regulations, Colorado Stormwater Management Program, and Water Discharge permitting programs.

**Champaign Creek Mine, Gold Fields Mining Company and Beema Gold, Inc., Idaho.** Project Manager responsible for pre-acquisition due diligence, exploration permitting, and reclamation and development of the production permitting strategy for this heap leach gold project located in Eastern Idaho. Assisted in sale of the property and its removal from the CERCLIS list of potentially Hazardous Waste Sites by successful development and implementation of remedial measures.

**Zaca Project, California.** Project Manager. Responsible for preparation of a Voluntary Remedial Measures Plan proposal to the Lahontan Regional Water Quality Control Board addressing historic acid mine drainage from several adits to the Carson River. The plan formed the basis for a settlement framework. The property owner, the Forest Service, and the RWQB are addressing the site jointly as a CERCLA action. Responsible for the technical aspects of the EE/CA removal action.

**Western States Minerals/Toiyabe National Forest Land Exchange, Nevada.** Responsible for all environmental aspects for this 3,500-acre land exchange in Central Nevada. Work included responsibility for T&E Species, Cultural and Historic Sec. 106 compliance, wetlands, hazardous materials surveys, biologic surveys, and floodplains, as well as preparation of an environmental assessment.

**Corona Gold Inc. - Santa Fe Mine.** Project Manager. Responsible for all baseline studies, permit application preparation and co-author of the BLM EA for this 2,000 ton per day open-pit, heap leach gold mine located in central Nevada.

**Watts, Griffiths and McQuitt Limited.** Project Manager responsible for conducting due diligence survey of Canyon Resources mines and advanced stage exploration projects. Work included permit and compliance review, reclamation plan review, and environmental cash flow estimation from the time of the study through closure, reclamation, and bond release. The properties included the Kendall, 7-Up Pete, and McDonald Meadows mines in Montana; the Beartrack mine in Idaho; and the Briggs mine in California.

**Elkhorn Project, Gold Fields Mining Company, Montana.** Project Manager responsible for completion of several pre-acquisition due diligence studies of active cyanide heap-leach operations including operating and closure plan enhancements for these gold properties located in Central Montana. The work included coordination with DEQ, DSL, and the Montana Abandoned Mine Land Program. Prepared all necessary Montana and Forest Service exploration permits and developed the production permitting strategy.

**Gold Fields Mining Company - Florence Project.** Project Manager. Responsible for pre-acquisition due diligence, exploration permitting and reclamation and development of a production permitting strategy for this historic placer gold property located in central Idaho.

**Confidential Clients - DeLamar Mine.** As Project Manager, Mr. Gast was responsible for shadow review of the compliance record and calculation of the potential closure liability for this major precious metals mine. He later conducted a due diligence study at the time that the property was offered for sale.

**Eagle Mine Site - for Confidential Client.** Project Manager. Technical review of remedial investigations and feasibility studies conducted by EPA's contractor for a Superfund mining site located in Eagle County, Colorado. Responsible for review of all aspects of EPA's action.

**Gold Fields Mining Corporation - Red Cliff Project.** Project Manager. Environmental review; permits preparation and defense in support of this major underground exploration mine located within five miles of Vail, Colorado. Colorado and Eagle County exploration and 110 mining permits in addition to

Colorado air and water quality permits were prepared. Upon completion of mining activities, final reclamation for the site was negotiated, supervised and a bond release strategy developed. The reclaimed site won the Governor's Award due to innovative slope stabilization techniques.

**Sunshine Mining Company - Revenue - Virginus Mine.** Project Manager. Environmental review; permits preparation and defense in support of this major underground exploration mine located near Ouray, Colorado. A Colorado 110 mining permit was updated and transferred, a Construction Dewatering permit was obtained, maintained and closed, a mining Storm Water Permit was prepared along with a CPDS Permit.

**North Lily Mining Company - Silver City Heap Leach Project.** Project Manager. Development of heap leach closure plan including existing permit review and revisions to groundwater quality permit and reclamation plan for this Utah facility.

## EDUCATION

Northern Illinois U. - BS, Accounting and Finance  
U. Idaho, School of Mines. *Design and Operation of Small Scale Gold and Silver Mines and Mills.*  
U. Nevada, Mackay School of Mines. *Fundamentals of Mining.*

## PROFESSIONAL EXPERIENCE

Faculty Member for Colorado School of Mines Short courses:

*"Introduction to Gold and Silver for Miners, Prospectors and Investors," and "Gold and Silver for Experienced Miners, Prospectors, Processors and Investors."*

Speaker at Bureau of Land Management's Bonding Course, National Training Center, Phoenix, Arizona January 1999 and the National Solid Minerals Conference, Salt Lake City, Utah June 1999.

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## COMPANY PROFILE

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**ESA Consultants Inc. (ESA)** has provided engineering and geosciences consulting services to private and public sector clients since 1969. We are an employee-owned firm with offices in Bozeman, Montana and Fort Collins, Colorado. ESA provides site investigation, engineering analysis and design, and construction management services to support facility development, help identify and control risk, promote safe and cost-effective construction, and minimize facility operating and closure costs.

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Our firm currently maintains a staff with the qualifications and experience to support projects requiring expertise in the following disciplines:

♦ **Engineering**

Civil  
Environmental  
Geotechnical  
Hydraulic  
Structural

♦ **Geosciences**

Engineering geology  
Geology  
Ground water  
Hydrogeology

For nearly 30 years we have provided specialized services through applying fundamental principals of engineering and geoscience to projects involving:

♦ **Bridges**

♦ **Dams**  
♦ **Mines**  
♦ **Pipelines**  
♦ **Power plants**  
♦ **Railroads**  
♦ **Reservoirs**  
♦ **Site remediation**  
♦ **Tunnels**  
♦ **Utility corridors**  
♦ **Water conveyance and treatment**  
♦ **Water resource development**

This statement of qualifications provides an overview of the services we offer, resumes of key personnel assigned to the Zaca Project and representative project experience summaries. We would be happy to provide you with references or further information on any of our projects.



**ESA Consultants**

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## **SITE ASSESSMENTS**

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ESA provides multi-disciplined teams to perform environmental site assessments ranging in complexity from preliminary characterization studies to comprehensive evaluations for remedial design. This is accomplished through appropriate technical investigations and information management.

□ **Site reconnaissance and characterization**

- Soil and geologic sampling
- Land use determinations
- Soil, rock borings and pit excavations
- Foundations engineering

□ **Ground-water investigations**

- Aquifer tests
- Flow system modeling
- Water quality monitoring
- Chemical equilibrium modeling
- Solute transport modeling

□ **Surface-water investigations**

- Hydrologic and hydraulic studies
- Flood flow determinations
- Flood routing
- Water quality and flow monitoring

□ **Information and data management**

- Data management systems
- Quality assurance/quality control plans
- Data quality assessment and validation
- Documentation review



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## MINING PROJECT EXPERIENCE

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The project experience summarized below provides a sampling of ESA's mining-related work for both industry and public agencies.

- **Leviathan Mine Reclamation, California** for Anaconda Minerals Company: Geotechnical recommendations for reclamation of a massive sulfide deposit and waste dumps including landslide stabilization and stream channel stabilization; review of final reclamation plans and cost estimates for closure.
- **Blackbird Mine Project, Lemhi County, Idaho** for U.S. Forest Service: Developed conceptual ground-water flow model and evaluated alternative mining and abandonment plans as part of the ground-water hydrology section of an EIS for the proposed reopening of the Blackbird Mine; with ERT, Inc.
- **Olds Works/East Anaconda Development Area "Superfund" Site, Anaconda, Montana** for confidential client: ESA completed the Feasibility Study for this OU, and is currently completing the remedial design, including plans and specifications. Major design tasks include mass grading of tailings and other mine waste materials in coordination with design (by others) of a Jack Nicklaus golf course within the site boundaries; and design of engineered covers and in-place treatment methodologies (chemical admixtures and seeding) of exposed tailings and other mine wastes outside of the golf course.
- **South Willis Gulch Operations, Central City, Colorado** for Solution Gold, Ltd.: Geotechnical evaluation and design of leach pad and operating ponds for 250,000 ton gold leaching operation. Since the facility was located on a relatively steep slope in mountainous terrain, stability analyses were required in the design of the pad/liner/heap system. Work included design of surface water control, recommendations for an underdrainage system to drain natural seeps underlying the pad and ponds, and recommendations and supervision during the construction of the facilities.
- **Nevada Moly Project, Tonapah, Nevada** for Anaconda Minerals Company: Provided hydraulic analyses of deep, high capacity wells to project long-term yield; designed and supervised well field construction, development and testing.
- **East Pacific Mine, near Winston Montana** for the Department of Environmental Quality, Abandoned Mine Reclamation Bureau: Developed work plans and field sampling plans for reclamation investigations at abandoned mines and millsites; conducted site characterizations in support of risk assessments and provided detailed analyses of reclamation alternatives.
- **Grizzly Gulch Tailings Dam, Lead, South Dakota** for Homestake Mining Company: Evaluation of seismicity of area and development of seismic design parameters for liquefaction evaluation of mine tailings. Extensive laboratory testing of tailings materials were conducted to establish their static, dynamic and residual strength characteristics.
- **Gem Mountain, Philipsburg, Montana** for AGC, USA: Conducted baseline data acquisition and prepared the operating permit application for three open pit mineral deposits. Baseline work included the documentation of a unique plant population for avoidance during mining and the recording of certain cultural sites for historic registry. Applications included permitting activities with the US Forest Service and the





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## MINING PROJECT EXPERIENCE

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actual implementation of field inspections on behalf of the Forest Service as an objective third-party expert.

- **Redcliff Mine Reclamation, Colorado** for Goldfields Mining Company: Designed and supervised construction of mass grading to stabilize a major landslide; reclamation of settling ponds; and stream stabilization measures for mine closure.
- **Butte District Mine Flooding Control Project, Butte, Montana** for confidential client: Compiled hydrogeologic data and developed graphic illustrations of mine flooding conditions in extensive abandoned underground and open-pit workings; performed engineering evaluations and cost analyses and developed alternatives for East Camp mines water level control.
- **Golden Jubille Mine, Georgetown, Montana:** Developed the baseline criteria and mine plan evaluation for a Small Miners Exclusion Permit and Exploration License.
- **Golden Sunlight Mine EIS, Whitehall, Montana** for Placer Dome: Conducted geotechnical stability assessment and hydrological analysis for mine expansion including assessment of major landslide complex.
- **Sunnyside Gold, Jerritt Canyon, Carlin Mine and Chimney Creek Tailings Dam, Utah and Nevada** for Knight Piesold & Co.: Evaluation of seismicity of area and development of seismic design criteria for use in liquefaction and slope stability analyses of dam embankment and tailings. Static and cyclic triaxial tests were conducted to establish static, dynamic and residual strength characteristics of tailings.
- **Druid Mine Expansion, Central City, Colorado** for Solution Gold, Ltd.: Geotechnical evaluation and design for a new 500,000 ton leach pad to expand the South Willis Gulch operations. Stability evaluation of the pad/liner/heap system was required due to its location on a 9 degree natural slope, and specific recommendations were made to the engineering design and plan of operations regarding surface grading and construction of the pad.
- **Emery Mine, near Deer Lodge Montana** for the Department of Environmental Quality, Abandoned Mine Reclamation Bureau: Developed work plans and field sampling plans for reclamation investigations at abandoned mines and millsites; conducted site characterizations in support of risk assessments and provided detailed analyses of reclamation alternatives.
- **Carr Fork Mine and Smelter Reclamation, Utah** for Atlantic Richfield Company: Provided geotechnical input to channel stabilization through slag dumps and tailings deposits; sited wastes to prevent ground-water contamination; and provided general review of overall reclamation plans including estimates of construction costs for closure of a major copper mine.
- **Kerby Mine, Oregon** for Malheur Mining Company: Site geology was characterized by landslide deposits and high plasticity clay soils in relatively steep terrain, presenting particular challenges to the siting and design of a leach pad, operating ponds, and ore storage area. Site investigation included geotechnical mapping of geologic and geomorphic features. Material strength properties for the native soils were based on laboratory shear testing, confirmed with back-calculations on an existing natural landslide. Stability analyses were performed



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## MINING PROJECT EXPERIENCE

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for the operating pond embankment, ore storage area, waste rock disposal area, and the proposed leach pad site, which included overall heap stability, foundation failure, and sliding on the pad liner.

- **San Manuel Tailings Dam, Arizona** for Magma Copper Company: Performed stability analyses, seepage analyses and provided recommendations for design of embankment raises and seepage and water quality control for six tailings ponds.
- **Nancy Lee Mine and Millsite, Slowey Mine, near Superior, Montana** for the Department of Environmental Quality, Abandoned Mine Reclamation Bureau: Developed work plans and field sampling plans for reclamation investigations at abandoned mines and millsites; conducted site characterizations in support of risk assessments and provided detailed analyses of reclamation alternatives.
- **Warm Springs Ponds Operable Units, Silver Bow Creek NPL Site, Montana** for confidential client: Provided engineering analysis, remedial design, construction oversight, and operation and maintenance plans for this large settling pond/water treatment complex to remove heavy metals from Silver Bow Creek. Provided design and construction quality control for removal of approximately 450,000 cubic yards of tailings from 4-mile long flood channel. Design and construction oversight provided for stabilization and raising of 7 miles of embankment dams for 17,000 acre-feet storage capacity; new inlet and outlet works and emergency spillways; upgrade of water treatment plant for flows up 3,300 cfs; expansion and soil-cement slope protection of 5-mile, 70,000 cfs peak capacity flood channel; installation of ground-water interception system; and wet closures to chemically fix and isolate acid generating sulfide tailings.
- **Iron Mountain Mine "Superfund" Site, Redding California** for CH2M-Hill/ U.S. EPA: Consultation for development of concepts to control acid mine drainage and development of a work plan for a massive sulfide under-ground mine.
- **Bison Basin Uranium Solution Mining, Wyoming:** Coordinated the preparation of an Environmental Report for a proposed solution mining project in support of license applications to the U.S. Nuclear Regulatory Commission and the Wyoming Department of Environmental Quality. One of the major concerns was assuring that the quality of ground water was not going to be degraded after mining operations cease. ESA reviewed all geologic and hydrologic data, assessed the impacts and mitigation measures, and prepared the documents submitted to the regulatory agencies.
- **Dry Cottonwood Mine, Galen, Montana,** for Confidential Client: Conducted jurisdictional wetland surveys, sediment pond design, hydrological analysis, mine engineering and prepared the operating permit for a placer operation in an active stream drainage. Hydrological applications included rising limb run-off sampling and analysis.



# Edmund J. Schneider, P.G.

Associate Hydrogeologist/Engineering Geologist

## REGISTRATION/CERTIFICATION

Professional Geologist: Wyoming  
OSHA Health/Safety Training for Hazardous Waste  
Operations: 40-hr and 8-hr Supervisory Certification

## EDUCATION

M.S., Geology, Colorado State University, 1975  
B.S., Wildlife Biology, Colorado State University, 1968

## PROFESSIONAL BACKGROUND

Mr. Schneider is a registered professional geologist with 27 years of experience in hydrogeology, engineering geology and environmental geology. His responsibilities have included project management and technical investigations in soil, geologic and environmental hazard assessments, ground-water quality assessment, data management/data validation, remedial investigations and design, and remedial action construction oversight. Mr. Schneider's expertise includes: hydrostratigraphy, ground-water flow paths and aquifer hydraulic properties for a variety of water supply, construction dewatering, EIS's, hazardous waste site assessments, and remediation projects. His relevant Superfund experience includes engineering evaluation/cost analysis, feasibility studies (alternatives analysis), remedial design and construction oversight/quality control. Mr. Schneider is also experienced in preparation of permit applications, expert testimony at permit hearings, and negotiation with regulatory agencies.

## PROJECT EXPERIENCE

- **Rico Site EA Support-Document Review and VCUP Application.** Mr. Schneider served as Project Manager in the review of ARCO Rico Site archived files/documents and various other related sources of information. Discharge data and historic water quality data was compiled as a summary of the site background and an annotated bibliography of over 200 database records was created to assist ARCO in the Rico Site Environmental Assessment. He was responsible for preparing the complete voluntary cleanup application for six sites and assisted client in obtaining approval of the plan from the State of Colorado.

- **Warm Springs Ponds Operable Unit Soil and Ground Water Remediation, Butte/Silver Bow Creek NPL Site, Montana.** Served as environmental soils investigation leader and hydrogeologist for this operable unit. Mr. Schneider was responsible for development of an ore tailings and associated soils removal protocol on behalf of the client, in lieu of definitive EPA or State of Montana action level criteria for soil remediation. Development of the removal protocol involved extensive field exploration, soil analysis for heavy metals of concern, and statistical quantification of analytical data by material type and by depth within the affected soil profile. The protocol was approved by the EPA and applied effectively during the removal of approximately 430,000 cubic yards of tailings and associated soil materials from a three-mile reach of stream channel to protect the fishery in the Clark Fork River downstream of the site. In addition, Mr. Schneider was responsible for the assessment of ground-water quality and aquifer hydraulic properties required for the analysis and design of ground-water control systems, including ground-water interception and treatment for heavy metals.

- **East Tintic Operations, Eureka, Utah, for Chief Consolidated Mining Company and AkikoGold, Ltd.** Served as Project Manager and Associate Hydrogeologist in the evaluation of thermal saline ground-water conditions affecting deep underground mining operations at Burgin Mine, East Tintic Mining District. Involved analysis of hydrogeologic conditions resulting in high volume (9,000 gpm) mine dewatering requirements for deep mine levels, analysis of hot, saline ground-water quality, and development and cost analysis of potential alternatives for mine dewatering and mine water disposal.

- **Summitville Superfund Site Assessment, Colorado.** Reviewed technical documents from extensive administrative record and conducted site reconnaissance at NPL site subject to severe acid mine drainage conditions for confidential client. The study focused on a qualitative assessment to compare/contrast historic mining/milling operations with recent open pit gold mine/cyanide heap leach operations as major sources of hazardous substances and acid mine drainage in anticipation of potential litigation.



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**Edmund J. Schneider**

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- **Travona Mine, Silver Bow Creek/Butte Area CERCLA Site, Montana (for PRP).** Provide technical review and comments on the technical aspects of the EPA EE/CA for the Butte West Camp Mine Flooding Project. Independently developed alternatives and engineer cost estimates for flooded-mine water level control. Participated in EPA/PRP negotiations support for final alternative selection and implementation.
- **Butte "Superfund" Site for Anaconda Minerals Company.** Project Manager in charge of compiling hydrogeologic data and developing graphic illustrations of hydrogeologic conditions for educational presentations; included illustration of mine flooding conditions in extensive abandoned underground and open-pit workings in Butte, Montana.
- **Mill-Willow Bypass for Anaconda Minerals Company.** Developed designs to improve a major flood bypass channel around the Warm Springs Settling Ponds; mapped tailings deposits in channel for removal and designed improvements of dike configurations and riprap slope protection to meet flood criteria; designed emergency spillways for settling ponds.
- **Avon Industrial Area Hydrogeologic and Ground-Water Quality Assessments, California.** Performed hydrogeological analysis and evaluation of industrial-area contaminated ground-water, assessment of potential short-term and long-term impacts to deep municipal well-field water supply. Provided recommendations for an area-wide comprehensive ground-water monitoring program to detect any long-term changes in water quality.
- **Nevada Moly Project for Anaconda Minerals Company.** He performed well field analyses and provided consultation on well field expansion for this large open pit molybdenum mine and mill. Provided well field analyses to project long term reliability and yield of the existing wells and their impact on the ground-water basin; assisted in well field development; for a mine near Tonapah, Nevada.
- **Anaconda Smelter NPL Site, Montana.** Developed and supervised screening study (pre-NPL designation) under Study Agreement with EPA. Identified potential surface water and ground-water impacts from ore concentrating and smelting wastes. Participated in general technical oversight of smelter facility demolition and construction of interim on-site flue dust storage facility. Negotiations support for the PRP-lead RI Work Plan.
- **Blue Water Uranium Mill Site, Ground-water Quality Impact Assessment and Site Reclamation Plan, New Mexico.** Reviewed ground-water quality assessment report and advised management on potential long-term site remediation considerations for plant closure.
- **Butte District Flooded-mine, Ground-water Monitoring Project, Montana.** Prepared first Ground Water Monitoring Program (EPA and State approved) for the Butte area following shut down of mine dewatering operations (pre-NPL designation). Provided negotiation support with EPA and State of Montana regarding the ground-water monitoring program.
- **Jackpile-Paguate Uranium Mine Site, Reclamation Plan, New Mexico.** Provided technical review and comments for uranium reclamation plan.
- **Green Mountain Uranium Mine, Hydrogeologic Studies, Wyoming.** Supervised hydrogeological investigations requisite to mine permit application. Supported exploration permit application negotiations with the State.
- **Morgantown Coal Liquefaction Project, Ground-water Quality Studies and Hydrogeology, West Virginia.** Conducted hydrogeological and ground-water quality baseline investigations for environmental impact assessment. Performed sampling and analysis activities for both inorganic and organic (PNAs) target constituents.
- **Marquez Uranium Mill Project, Ground-water Discharge Plan, New Mexico.** Provided technical support regarding ground-water quality at public hearings. Conducted field inspection during construction of unlined tailings impoundment to confirm potential for leachate seepage problems.
- **Pearl Coal Mine Project, Hydrogeologic Study, Montana.** Conducted requisite hydrogeological investigations for mine permit application.

